Appendix A. Statement of Work
ISS Payload Operations Concept and Architecture Assessment Study (POCAAS)

Background

The concept of operations for user payloads on the International Space Station (ISS) is largely derived from experience gained over the last 20 years from Space Shuttle missions, which employed Spacelab modules/pallets or, more recently, Spacelab middeck augmentation modules. These missions were limited to less than 20 days due to Space Shuttle and crew flight duration constraints. As a result, the missions were highly optimized during the planning phase and executed around-the-clock with intensive near real-time replanning to maximize the research return from payload operations. In addition, payloads were designed to stringent requirements, at high cost, to ensure research mission success in the severely limited flight opportunity environment.

The ISS era promises near continuous payload operations as the completion of station assembly approaches. Although flight safety remains of paramount concern, the time constraints associated with research operations are significantly different, and the payload logistics problem fundamentally changed—after the ISS is initially outfitted with rack/pallet-scale experiment systems, the resupply of consumables and orbital replacement units (ORUs) becomes of greatest importance to maintaining laboratory and observatory productivity.

The overhead costs represented by these functions have consistently grown in proportion to the direct costs of doing the research. Recent fiscal constraints have necessitated this study to reexamine the costs associated with payload operations.

Period of Performance

Date of award to February 8, 2002

Task Statements

Task 1: The contractor will assess the current ISS concept of payload operations and the associated flight/ground architecture for efficiency improvements. This shall include the following elements:

- Payload Operations Integration Center and Functions (POIC/POIFs)
- Telescience Supports Centers and Functions (TSCs)
- Crew Training Centers and Functions
- Mission Control Centers for each ISS Partner

The contractor should consider prior or existing spacecraft that operate continuously or semicontinuously for applicability to the ISS. The effects of reduced time constraints, changes in logistics demands, rate-limiting resources, or other factors affecting the productivity of orbital laboratories and observatories are to be addressed for relevance.

Task 2: The contractor will recommend the potential for time-phased reductions in the cost of payload operations through the following approaches:

- Efficiency improvements to existing systems
- Interim or permanent changes to existing requirements on systems
- Changes to the current concept of payload operations to most effectively take advantage of continuity in ISS operations

Deliverables

1. Mid-term briefing to NASA management not later than December 1, 2001. The mid-term briefing shall include the status of the study, an estimate of the work remaining, a completion schedule, and any outstanding issues or questions to be addressed by NASA.
2. Final briefing of the findings and recommendations to NASA management not later than January 17, 2002.
3. Twenty-five hardcopies and five electronic copies of the final report due by January 31, 2002. The final report shall include the following types of recommendations:
    a. A description of existing NASA payload operations systems with recommended efficiency improvements
    b. An analysis and recommended interim and permanent changes to current NASA user development requirements
    c. Recommendations on changes to the ISS concept of operations that take full advantage of the continuous operations environment afforded by the ISS

Appendix B. Biographical Sketches of POCAAS Study Team Members

John-David Bartoe, Ph.D.

Current Title: Research Manager, International Space Station Program Office, National Aeronautics and Space Administration

Relevant Experience: Dr. Bartoe is Research Manager for the International Space Station (ISS) at NASA's Johnson Space Center. He provides oversight for the Program Manager concerning the research capability, research hardware, and research plans of the ISS. Prior to his present position, Dr. Bartoe was Director of Operations and Utilization in the Space Station Office of NASA Headquarters from 1990 to 1994. He also served as Chief Scientist for the Space Station from 1987 to 1990. Before coming to NASA Headquarters, he flew on Space Shuttle Mission 51-F (July 29 to August 6, 1985) as a civilian Navy payload specialist. A physicist by training, Dr. Bartoe was co-investigator on two solar physics investigations aboard this mission, designated Spacelab 2, that were designed to study features of the Sun's outer layers. In completing this flight, Dr. Bartoe traveled more than 2.8 million miles in 126 Earth orbits and logged more than 190 hours in space. From 1966 to 1988, Dr. Bartoe worked as an astrophysicist at the Naval Research Laboratory in Washington, D.C., and published more than 60 papers in the field of solar physics observations and instrumentation

Professional Accomplishments: Dr. Bartoe is a member of the Association of Space Explorers and is Chairman of the Space Station's Committee of the International Astronautical Federation. His awards include the NASA Exceptional Achievement Medal, the Navy Distinguished Civilian Service Award, the Flight Achievement Award of the American Astronautical Society, the NASA Space Flight Medal, and the NASA Skylab Achievement Award.

Education: B.S., physics, Lehigh University (1966); M.S. and Ph.D., physics, Georgetown University (1974 and 1976)

John M. Cassanto

Current Title: Founder of Instrumentation Technology Associates Inc. (ITA), Chief Executive Officer and Chairman of the Board

Relevant Experience: Mr. Cassanto has 25 years' experience with the General Electric Company (GE) in Department of Defense (DOD) missile and reentry vehicle flight test programs, including launch vehicles, orbital free fliers, orbital recovery capsules, reentry vehicles, and DOD satellite integration on the Shuttle. He formed ITA in 1983 to provide commercial space infrastructure elements for private sector space initiatives. He negotiated three separate Commercial Space Act Agreements with NASA for the flight of commercial payloads on the Shuttle. His firm has flown commercial microgravity payloads on eight Space Shuttle flights, eight sounding rockets, one Mir mission, and four Low-G aircraft flights. ITA also developed generic low cost multi-user space processing hardware to reduce the cost of conducting microgravity experiments in space. His company under contract to JSC has developed, fabricated, and tested the MEPS payload scheduled to fly on the UF-2 ISS mission.

Mr. Cassanto has been a vocal supporter of NASA's commercial space initiatives for 20 years and a proponent of space policies to encourage the U.S. private sector to invest in space research.

Professional Accomplishments: Mr. Cassanto was the GE Project Engineer responsible for the company's effort for the design, development, and ground and flight testing of the DOD Minuteman missile nosetip program as well as for meeting milestones on time within budget. He has testified on three occasions before the U.S. House of Representatives Subcommittee on Science, Space, and Technology regarding NASA's commercial space program. His company was the first to successfully demonstrate the feasibility of microcapsulation of drugs technology in space on a commercial sounding rocket, and has sponsored cancer research projects on Shuttle flights. Mr. Cassanto developed a private-sector student space outreach experiment program and has flown student piggyback experiments for more than 30 schools and has interacted with more than 2000 students over the past decade. He has published more than 50 papers dealing with reentry vehicle flight tests, Shuttle microgravity experiments, and various microgravity carriers for orbital recovery capsules and Shuttle applications.

Education: B.S., aeronautical engineering, Pennsylvania State University; "A" course graduate of the GE engineering/management course; and post graduate engineering and management courses, Villanova University

John Cox, Ph.D.

Current Title: Director, Computer Sciences Corporation

Relevant Experience: Dr. Cox has a long career in flight training, flight operations, and program management. He served as Shuttle program flight director; was the utilization and operations manager, deputy program manager, and acting program manager for the Space Station Freedom Program; and was the operations manager on the Space Station redesign team. He served on two National Research Council study teams related to International Space Station (ISS) issues and served as chairman of the CSC-led ISS Operations Architecture Study.

Professional Accomplishments: In the Skylab program, Dr. Cox served as the lead biomedical officer, flight training manager, and flight director; for Space Station, he was the director of utilization and operations, deputy program manager, and acting program manager. He chaired the ISS Operations Architecture Study, served as the operations manager on the original Space Station Operations Task Force study that defined the utilization and operations for the phase A/B program, and served as Code U organizational operations advisor.

Education: B.S., mechanical engineering, University of California at Berkeley; M.S., aerodynamics, and Ph.D., biomedical engineering, University of Houston

Roger K. Crouch

Current Title: Senior Scientist for International Space Station, Office of Space Flight, National Aeronautics and Space Administration

Relevant Experience: Mr. Crouch has been on loan from MIT to NASA Headquarters as the Senior Scientist for the International Space Station since 2000. Prior to that, he was on loan from MIT as the Senior Scientist for the Office of Life and Microgravity Sciences, NASA Headquarters (1998-2000); for crew training, flight, and post-flight activities (1996-1998); and as Lead Scientist of the Microgravity Space and Applications Division (MSAD) (1985-1996).

Mr. Crouch organized and served as co-chair for Microgravity Science Working Groups between NASA and the European Space Agency and space agencies from France, Germany, Japan, and Russia. He was the founding co-chair of the International Microgravity Science Strategic Planning Group consisting of these space agencies plus Canada. He was principal investigator on an experiment that flew in the Materials Experiment Apparatus on the D-1 mission in 1985. As group leader and researcher at NASA Langley Research Center (1962-1985), Mr. Crouch led a research group investigating the effects of convection on semiconductor materials' properties. He was a principal investigator in the MSAD flight program from 1985-1997. This research resulted in the publication of more than 40 technical papers and more than 50 technical conference reports.

Professional Accomplishments: Mr. Crouch was a payload specialist on STS-83 (April 4-8, 1997) and STS-94 (July 1-17, 1997) and has logged more than 471 hours in space. He trained as the alternate payload specialist on STS-42 (First International Microgravity Laboratory), which flew in January 1992. His awards include the Distinguished Alumni Achievement, Virginia Tech, 1998; Distinguished Alumnus 1997, Tennessee Technological University; NASA Exceptional Performance Award, 1989; NASA Special Achievement Award, 1983; and the Floyd Thompson Fellowship, 1979-80. Mr. Crouch has received certificates for patents/ applications in 1975, 1985, 1986, and 1987, and certificates for innovative technology in 1973, 1976, 1979 – 1981, and 1985 – 1987.

Education: B.S., physics, Tennessee Polytechnic Institute (1962); M.S. and Ph.D., physics, Virginia Polytechnic Institute (1968 and 1971); visiting scientist at Massachusetts Institute of Technology in 1979-80

Larry DeLucas, O.D., Ph.D

Current Title: Director of the Center for Biophysical Sciences and Engineering

Relevant Experience: Dr. DeLucas served as Chief Scientist for the International Space Station at NASA Headquarters and as a crew member (payload specialist) on STS-50, Microgravity Laboratory-1 Spacelab mission. He received the NASA Research Award for the research hardware patent entitled "Protein Crystal Growth Vapor Diffusion Apparatus for Microgravity." His professional affiliations have included the following: member, Scientific Advisory Board, National Space Development Agency of Japan; Chair, Science Advisory Board, Diversified Scientific, Inc.; member, Board of Trustees, Illinois College of Optometry; member, SPACEHAB Science Advisory Board; member, NASA Space Station Science Utilization and Advisory Subcommittee; member, U.S. Space and Rocket Center Advisory Committee; member, American Institute of Aeronautics and Astronautics (AIAA) Space Processing Technical Committee; member, graduate faculty, University of Alabama at Birmingham; member, NASA Science Advisory Committee for Advanced Protein Crystal Growth; professor, Department of Optometry, University of Alabama at Birmingham; Director, Center for Biophysical Sciences and Engineering, University of Alabama at Birmingham.

Professional Accomplishments: Dr. DeLucas has published more than 100 research articles and co-authored two books; he was the co-inventor of 25 patents and a crew member on STS-50.

Education: B.S. and M.S., chemistry, University of Alabama at Birmingham; B.S., physiological optics, University of Alabama at Birmingham; O.D., optometry, and Ph.D., biochemistry, University of Alabama at Birmingham

Dale L. Fahnestock

Current Title: Goddard Space Flight Center Account Manager, Computer Sciences Corporation

Relevant Experience: Mr. Fahnestock has more than 32 years of NASA experience at Goddard Space Flight Center (GSFC), which included positions as former Director, Mission Operations and Data Systems; Deputy Director, MO&DSD; Chief, Information Processing Division; and Chief, Mission Management Office. He headed the major NASA organization in providing complete end-to-end ground system services, including the worldwide ground network, Tracking and Data Relay Satellite System (TDRSS) network, NASA Communications (Nascom) worldwide communications, control centers and mission operations, flight dynamics, data processing, and data product generation for hundreds of experimenters worldwide for many unmanned spacecraft missions, STS, Spacelab, and international agencies. He spent 6 years in industry as an account manager and developer of operations concepts and architectures for NASA spaceflight operations.

Professional Accomplishments: Mr. Fahnestock was the recipient of the NASA Outstanding Leadership Medal. As Chairman of the interagency Network Control Group, he achieved agreements to utilize worldwide tracking and data acquisition assets, led the activity to develop the first catalog of all U.S. tracking and data assets; led the development and completion of ground systems for more than 100 missions and supported all missions successfully at launch on schedule; and reviewed and certified ground system and communications readiness for many STS missions. As Chairman of the Space Network Interoperability Panel (SNIP), he achieved agreements for the European Space Agency's and the National Space Development Agency of Japan's space network compatibility with TDRSS.

Education: B.S., electrical engineering, Newark College of Engineering; graduate studies, University of Maryland and New Jersey Institute of Technology; graduate, Defense Weapons Management School at Wright Paterson Air Force Base

Owen Garriott, Ph.D.

Current Title: Research Professor at the University of Alabama in Huntsville, Alabama

Relevant Experience: Dr. Garriott served as the science-pilot of the second manned Skylab mission. His experiment responsibilities included extensive solar observations and studies of effects of extended weightlessness on humans. He repaired six gyros, nine experiments, operational equipment items, and installed a twin-pole solar sunshade as part of an extra-vehicular activity (EVA). He was a Mission Specialist on the Spacelab-1 flight with the European Space Agency lab, and served as Deputy Director and Acting Director of Science and Applications and as the Project Scientist for Space Station at NASA/Johnson Space Center. After leaving NASA, he served as Vice President for Space Programs at an aerospace contractor and was a key team member that developed the International Space Station Operations Architecture Study.

Professional Accomplishments: Dr. Garriott totaled over 13 hours in three EVAs on Skylab and received many recognitions, such as the NASA Distinguished Service Medal, Goddard memorial trophy, and NASA Space Flight Medal. He taught electrical engineering at Stanford University for 4 years before joining NASA.

Education: B.S., electrical engineering, University of Oklahoma; M.S. and Ph.D., electrical engineering, Stanford University; completed 1-year flight training with the United States Air Force, receiving pilot qualification in jet aircraft; Honorary Doctor of Science, Phillips University

Gerald Griffith

Current Title: Senior Engineer, JAMSS America, Inc.

Relevant Experience: Mr. Griffith's experience includes training instructor [flight dynamics for Gemini and Apollo Mission Control Center (MCC) operations], MCC controller on Apollo and Skylab in experiment operations; technical consultant to chief, Astronaut Office, in payload interfaces and crew safety; and 10 years as Astronaut Office representative to the Payload Safety Review Panel. Currently he is supporting National Space Development Agency of Japan activities on the International Space Station (ISS).

Professional Accomplishments: Mr. Griffith is a recognized expert and advocate for crew safety; he led experiment support efforts for flight operations teams during Apollo and Earth resources team on Skylab and has had a key role in streamlining/evolving Shuttle and ISS payload safety review processes.

Education: B.S.M.E., Texas A&M University; M.S.M.E., University of Illinois; postgraduate work, Public Administration, University of Houston

Robert K. Holkan

Current Title: President and Chief Executive Officer, MTS Global, Inc.

Relevant Experience: Mr. Holkan's 34-year NASA career includes experience in flight control, training, facilities, and management at Johnson Space Center.

As Chief, Simulation Operations and Technology Division, Mr. Holkan was responsible for operations and development of the Shuttle Mission Simulator, Space Station Training Facility, and all part-task trainers.

Prior to this, Mr. Holkan was Assistant Director for Facilities for the Mission Operations Directorate, which included development and operations of flight simulators, flight software reconfiguration, and the Mission Control Center. Mr. Holkan also served as Chief, Training Division responsible for development and execution of Space Shuttle astronaut training for vehicle systems and payloads. As Chief, Astronomy Experiments Section, Mr. Holkan provided training to the Skylab I crew on solar experiments.

Additional activities included leading cross-organizational teams in the development of strategic plans for the Mission Operations Directorate, leading a Systems Engineering team to establish the design of the Space Station Training Facility, and leading a review team assessing the performance of Space Station contracts on a programwide basis.

Professional Accomplishments: Honors received by Mr. Holkan include the JSC Certificate of Commendation and the NASA Exceptional Service Medal. He is a member of the Clear Lake Area Economic Development Foundation and serves on their Small Business Committee.

Education: B.S., math and chemistry, Southwestern State University; postgraduate courses: math, University of Oklahoma, and management, University of Houston

Fletcher Kurtz

Current Title: Director, High Performance Computing Center of Excellence, Computer Sciences Corporation

Relevant Experience: Mr. Kurtz served as program manager and chief engineer of the Huntsville Operations Support Center, including the Spacelab Payload Operations Center and the Space Station Payload Operations Integration Center. He supported operations definition and implementation for the HEAO, Hubble, and Chandra free-flying observatories. He has 32 years' experience at NASA and 10 years' in industry, including experience as chief technologist for information technology, business process reengineering for the States of Florida and Alabama, and business unit manager. Currently Mr. Kurtz is consulting for the Marshall Space Flight Center on the Payload Operations Integration Center cost-reduction study.

Professional Accomplishments: Mr. Kurtz's professional accomplishments include Director, High Performance Computing Center of Excellence for CSC; vice-president, Computer System Integration for Nichols Research Corporation; program manager, U.S. Air Force Aeronautical Systems Center Major Shared Research Center; and key advisor and contributor, International Space Station Operations Architecture Study.

Education: B.A., physics, Vanderbilt University; M.A., physics, Vanderbilt University; graduate studies, University of California at Berkeley and University of Alabama Huntsville

Charles Lewis

Current Title: Consultant

Relevant Experience: Mr. Lewis served as chief of the Marshall Space Flight Center (MSFC) Mission Training Division, where he was responsible for flight crew and ground support training for Spacelab and Space Station payload operations, and for integration and development of man-systems design standards. As Deputy Chief, MSFC Mission Engineering Division, he had responsibility for planning, direction, coordination, and leadership of engineers and support personnel for flight operations, operations planning and analysis, flight and ground crew training, and man-systems integration. As the Primary Spacelab 1 Crew Training Coordinator, he developed the initial Spacelab payload crew training approach for international multidisciplinary scientific experiments.

Professional Accomplishments: Mr. Lewis' professional accomplishments include Division Chief, operations training for Spacelab and Space Station; Spacelab training coordinator; Spacelab 1 ground communicator; member of the original Space Station Operations Task Force; crew systems development and simulation support of Skylab extra-vehicular activity systems, including the twin-pole solar shield and solar array deployment.

Education: B.S., electrical engineering, Detroit Institute of Technology

Byron K. Lichtenberg, Sc.D.

Current Title: Consultant

Relevant Experience: Dr. Lichtenberg founded Payload Systems, Inc. He provided hardware and flight support for the MODE and MACE experiments for the Space Shuttle. Payload Systems, Inc., was the first commercial user of the MIR Space Station. He was an investigator for MIT/Canadian Vestibular experiments on Spacelab 1, Spacelab D-1, and Spacelab SLS-1 and SLS-2, and co-principal investigator for the Mental Workload and Performance experiment assessing human-computer workstation characteristics for the Space Station. Dr. Lichtenberg was a payload specialist on the ATLAS-1 Spacelab mission (9 days in 1992) and the Spacelab-1 mission (10 days in 1983); he conducted multiple experiments in life sciences, materials sciences, Earth observations, astronomy and solar physics, and upper atmosphere and plasma physics.

Professional Accomplishments: Dr. Lichtenberg's professional accomplishments include founding member, Association of Space Explorers; member, User Panel for National Space Biomedical Research Institute; member, National Research Council Committee on Engineering Research and Technology Development on the International Space Station; member, NASA Task Force on the Scientific Uses of Space Station; and recipient of the NASA Spaceflight medal, the AIAA Haley Spaceflight Award, and the FAI Komorov Award.

Education: Sc.D., Westminster College (honorary); Sc.D., biomedical engineering, MIT (1979); S.M., mechanical engineering, MIT (1975); Sc.B., aerospace engineering, Brown University (1969)

John O'Neill

Current Title: Consultant

Relevant Experience: Mr. O'Neill was the first director and organizer of the Space Operations Office, which provides Agency-wide mission and data services. He was Director of Mission Operations at the Johnson Space Center (JSC) (1994 – 1996) and Deputy Director for 7 years prior. He has 34 years' total NASA operations experience. Mr. O'Neill led preflight planning, training, and real-time flight control of NASA human space flight missions and payload operations; developed operations concepts as a member of the Space Station Redesign Team; and was instrumental in the evolution of the facilities and systems involved in mission development and support.

Professional Accomplishments: Mr. O'Neill's NASA operations experience spans the Gemini, Apollo, Apollo-Soyuz, Skylab, and Shuttle programs and early Space Station development. He was Chief, Payload Operations Division during formulation of Shuttle payload operations processes.

Education: B.S., mechanical engineering, University of Nebraska; M.S., mechanical engineering, University of New Mexico; Program for Management Development, Harvard Business School

Ron Parise, Ph.D.

Current Title: Researcher, Internet in Space, Computer Sciences Corporation

Relevant Experience: Dr. Parise, while working at Operations Research Inc. upon graduation in 1979, was involved in developing avionics requirements definitions and performing failure mode analyses for several NASA missions In 1980 he began work at Computer Sciences Corporation (CSC) in the International Ultraviolet Explorer (IUE) operations center as a data management scientist and in 1981 became the section manager of the IUE hardcopy facility. In 1981 he began work on the development of a new Spacelab experiment called the Ultraviolet Imaging Telescope (UIT). His responsibilities involved flight hardware and software development, electronic system design, and mission planning activities for the UIT project

In 1984, NASA selected him as a payload specialist in support of the newly formed Astro mission series. During his 12 years as a payload specialist, he was involved in mission planning, simulator development, integration and test activities, flight procedure development, and scientific data analysis, in addition to his flight crew responsibilities for the Astro program. A veteran of two space flights, Dr. Parise has logged more than 614 hours and 10.6 million miles in space. He served as a payload specialist aboard STS-35 in 1990 and STS-67 in 1995.

STS-35/Astro-1 Columbia (December 2-10, 1990). The Astro observatory is a unique complement of three telescopes designed to simultaneously record spectral data, polarimetric data and imagery of faint astronomical objects in the far ultraviolet. Mission duration was 215 hours and 5 minutes. Landing was at Edwards Air Force Base in California. c*STS-67/Astro-2 Endeavour (March 2-18, 1995).* This was the second flight of the Astro observatory. During this record-setting 16-day mission, the crew conducted observations around the clock to study the far ultraviolet spectra of faint astronomical objects and the polarization of ultraviolet light coming from hot stars and distant galaxies. Mission duration was 399 hours and 9 minutes. Landing was at Edwards Air Force Base in California.

At the completion of the Astro program, Dr. Parise assumed an advanced planning and communications engineering support role for a variety of human spaceflight projects including Mir, International Space Station, and the X-38. Dr. Parise has engaged in a number of astronomical research projects utilizing data from ground-based observatories, the Copernicus satellite (OAO-3), IUE, and the Astro observatory. His research topics, including circumsteller matter in binary star systems and the evolutionary status of stars in globular clusters, have resulted in several professional publications.

Currently, Dr. Parise is supporting the Goddard Space Flight Center, Networks and Mission Services Project, in the area of advanced communications planning for human spaceflight missions. He is also involved with projects in the Advanced Architectures and Automation Branch that are developing the use of standard Internet Protocols in space data transmission applications.

Professional Accomplishments: Dr Parise is a member of the American Astronomical Society, Astronomical Society of the Pacific, Association of Space Explorers, International Astronomical Union, Sigma Xi, and Phi Kappa Phi. He has twice been awarded the NASA Space Flight Medal, in 1991 and 1995. Other honors bestowed on him include distinguished member of Phi Kappa Phi, 1996; Honorary Doctor of Science, Youngstown State University, 1996; NASA/GSFC Special Act Award, 1995; CSC, Space and Earth Technology Systems, Award for Technical

Innovation, 1999; NASA Group Achievement Award, 1988, 1991, 1992, 1996, 1998, 2000; NASA/GSFC Community Service Award, 1990; and Allied Signal, Quest for Excellence Award, 1997.

Education: B.S., physics, with minors in mathematics, astronomy, and geology, Youngstown State University, Ohio (1973); M.S. and Ph.D., astronomy, University of Florida (1977 and 1979)

Edward Pavelka

Current Title: Consultant

Relevant Experience: Mr. Pavelka has a broad range of expertise in trajectory planning, management (for Apollo, ASTP, and Shuttle flights), and Mission Control Center operations support, operations planning, payload operations, flight planning, and facilities development. He served as Chief, Operations Division, responsible for operations and planning for payload support, flight planning, and trajectory activities for all Shuttle flights, development of payload integration, and integrated cargo hazard assessment processes. Mr. Pavelka has 3 years of experience working with Boeing in assessment of payloads compliance with ISS requirements. He has also supported the United Space Alliance in implementing the Operations Controls Agreement Safety Database (OCAD). He supported the POCAAS CSC study effort as a team member specializing in ISS planning.

Professional Accomplishments: Mr. Pavelka's professional accomplishments include section head, Flight Dynamics; branch chief, Flight Planning; division chief, Operations Division, MOD; deputy assistant director for Shuttle Operations, MOD, and USA project lead, Operations Controls (Safety).

Education: B.S., aerospace engineering, University of Texas at Austin; graduate studies at The University of Houston, Clear Lake, related to the JSC Management Development Program

Tom Recio

Current Title: Consultant

Relevant Experience: Mr. Recio has 25 years' experience in manned and unmanned payload operations planning and execution. He served as operations manager for the Einstein Observatory, was Payload Operations Director for the SL-1 mission, and Chief of the MSFC Operations Integration Office. He lead the team that performed the operations reengineering study for the Hubble Space Telescope Science Institute. Mr. Recio has 6 years' experience in industry in payload hardware development, payload integration, and utilization support for the International Space Station, and has been Deputy Manager of the Payload Utilization Contract.

Professional Accomplishments: Mr. Recio was Manager, MSFC Operations Integration Office and Deputy Manager, ISS Payload Utilization. He was the recipient of two NASA Exceptional Service Medals.

Education: B.S.I.E., University of Florida; graduate studies, University of Alabama in Huntsville

Al Sacco, Jr., Ph.D.

Current Title: George A. Snell Distinguish Professor of Engineering, Northeastern University

Relevant Experience: Dr. Sacco holds the George A. Snell Chair of Engineering and is Director, Center for Advanced Microgravity Materials Processing at Northeastern University. He was the Department Head/Professor at Worcester Polytechnic Institute, Department of Chemical Engineering. Dr. Sacco served as backup payload specialist on STS-50, a payload specialist on STS-73, and principal investigator and payload developer for the Zeolite Crystal Growth experiments. He has performed as a consultant in the fields of catalysis, solid/gas contacting, and equipment design for space applications. He lead the Science and Technology Working Group to evaluate NASA's Advance Life Support Program.

Professional Accomplishments: Dr Sacco was the principal investigator for STS-50, STS-57, STS-73, and UF-1 and 8A. He has been published more than 150 times in the areas of carbon filament initiation and growth, catalyst deactivation, and zeolite synthesis and microgravity materials processing. He received the Admiral Earl award for meritorious contributions in applied sciences before age 35. He is a member of the Worcester Engineering Society and the International Academy of Astronautics, is an elected fellow of the AIChE, has received the NASA Space Flight Medal, and was awarded the Christy McAuliffe Outstanding Teacher Medal.

Education: B.S., chemical engineering, Northeastern University; Ph.D., chemical engineering, MIT; two honorary doctorates of engineering (Northeastern University and Worcester State College) and one honorary doctorate in science (Worcester Polytechnic Institute)

Carl Shelley

Current Title: Chief Engineer, JAMSS America, Inc.

Relevant Experience: Mr. Shelley has flight operations experience at NASA Johnson Space Center (JSC) on all of the manned spaceflight programs, including flight crew and flight controller training, flight control team operations, crew procedure development, flight planning, and payload operations. He was deputy director of MOD; manager of the Space Station Freedom program utilization activities for 2 years; deputy manager of JSC Space Station Projects Office (5 years); assistant manager, Space Shuttle Program (4 years); and is currently chief engineer, JAMSS America, Inc., supporting National Space Development Agency of Japan activities on the International Space Station.

Professional Accomplishments: Mr. Shelley co-chaired the Space Station Operations Task Force study in 1987, which originated the Payload Operations Integration Center concept. He served as deputy project manager for SSF work package 2 development. Mr. Shelley provided Shuttle Program management planning and implementation for the Space Flight Operations Contract awarded to United Space Alliance. He was an advisor on and contributor to the International Space Station Operations Architecture Study.

Education: B.S., electrical engineering, Auburn University; postgraduate courses, electrical engineering, University of Southern California and University of Houston

Jerry Weiler

Current Title: Senior Analyst, Morgan Research Corporation, Huntsville, Alabama

Relevant Experience: Mr. Weiler was Chief, Mission Planning Division, Marshall Space Flight Center (MSFC). He has experience in design and operation of mission planning systems, as well as in the conduct of analysis and planning of space missions. He served as payload activity planning officer for Spacelab missions, and designed and developed the MSFC Mission Integrated Planning System. He currently is performing independent verification and validation (IV&V) of the International Space Station Payload Planning System.

Professional Accomplishments: Mr. Weiler has NASA experience in Apollo, Skylab, Spacelab, and Space Station operations and software development. He was the Payload Activity Planner for Spacelab Missions and the Mission Integration Branch Chief and Chief, MSFC Mission Planning Division.

Education: B.S., University of Alabama; graduate studies, University of Alabama at Huntsville

Appendix C. Researcher Survey

This appendix provides detail regarding the researcher survey whose results were discussed in Section 2.4 of this report. The appendix contains four parts:

1. A narrative description of the survey and detailed analysis of its results.
2. A copy of the survey questionnaire
3. A listing of the addresses of the questionnaire
4. A compilation of the comments received in response to the questionnaire.

Appendix C
Part 1. Survey Description and Analysis

C.1 Researcher Perspectives

The active researchers on the POCAAS Team identified a number of issues that they believe cause unnecessary cost for ISS research and inhibit researchers who would potentially use the ISS as a research facility:

- Current ISS payload practices (not confined to payload operations) are resulting in a document burden on the principle investigators that is significantly greater than for Spacelab or other past human space missions.
- The ISS Payload Data Library requires excessive researcher effort to maintain and is not always used by the NASA Payload Operations personnel
- ISS Payload operations planning and execution practices enforce adherence to standards and programmatic requirements to unnecessary degree
- ISS Payload operations planning and execution practices are overly formalized with multiple approval levels
- Multiple changes in interpretation of requirements for developing ISS crew flight procedures increase researcher workload unnecessarily.

C.1.1 Researcher Issue Validation Survey

At the request of NASA, the study team assembled a brief questionnaire to test the validity of these issues, identify any additional issues, and gather any recommendations on how to address the issues. A copy of the questionnaire assembled by the POCAAS study team is included in this appendix.

The following sections describe the questionnaire survey, data, and results in more detail.

C.1.2 Method and Respondents

The researcher issues identified by the POCAAS team were used, as is, for the content of the questionnaire. All 61 researchers listed with the ISS research office who were participating in ISS research through increment 6 were invited to respond by rating their level of agreement with each issue according to the following scale:

- 0=Insufficient direct knowledge or experience on which to base a response
- 1=Strongly Disagree
- 2=Somewhat Disagree
- 3=Somewhat Agree
- 4=Strongly Agree

The scale was developed to provide a forced-choice response set, but allow for the likelihood that the respondent may judge they had insufficient knowledge to respond to a particular question. Respondents were invited to provide comments or recommendations to each issue and were assured that their responses would be handled confidentially. Prior to sending out the questionnaire and in some of the responses, there was some comment that the questions/issues were negatively cast. In the background and instructions section of the questionnaire, we acknowledged this situation calling it to the awareness of the respondents and asking them not to be influenced by the questions' formulation. Dr. John-David Bartoe, NASA ISS research manager, served as the named point of contact. The questionnaires were sent in his name and responses were returned to him.

C.1.3 Respondent Characteristics

We received 37 responses for a response rate of 61 percent, which is a much higher-than-expected response rate. By design, there were no attempts made to contact or follow-up nonresponders. The number of respondents distributed across RPO and Headquarters organizations is shown in Exhibit C-1.

Exhibit C-1. Distribution of POCASS Researcher Questionnaire Respondents by Codes

Position	Summary	RPO					Headquarters Code				
		FB	HLS	MRPO	OSF		M	UB	UF	UG*	UM*
PI	18	3	7	7	1		1	8	2	6	2
PD	11	1	0	5	5		5	0	1	3	2
Both	8	0	1	3	4		4	1	0	2	1
Total	37	4	8	15	10		10	9	3	11	5
*One PI worked with both code UG and UM											

At the time the questionnaire was sent out, Increment 4 was flying on the ISS. The following represent the ISS-flight/increment-related experience of the 37 respondents. Of the 37 respondents

- 23 had payloads flying during Increment 4
- 7 were flying a payload on ISS for the first time during Increment 4
- 19 had flown more than increment by Increment 4
- 6 will fly their first ISS payload on Increment 5 or 6
- 24 had flown payloads on at least one increment prior to Increment 4
- 22 will have flown multiple increments by Increment 6

C.1.4 Data Analysis

The choices made around question construction, and population sampling and survey procedures warranted the use of simple analytical statistics such as descriptive statistics, t-tests, and one factor analysis of variance (ANOVA). Consider the results as indicative of trends and "pointers" to areas and topics requiring further explanation and clarification.

For the quantitative data analyses of the ratings, ratings of "0" (insufficient direct knowledge or experience on which to base a response) and the quantitative data from 5 additional questionnaires received from other associates/team members of the PIs/PDs invited to respond were excluded from the computations. The qualitative response analysis not only included the 79 comments/recommendations received from 23 respondents, but also an additional 20 comments received from the same 5 associates/team members of the PIs/PDs invited to respond.

The data analysis was structured as followed:

1. Determine the overall level of agreement/disagreement to each of the identified issues and the intensity of the agreement/disagreement.
2. Determine if there were any non-random differences in rating patterns among the PI, PD, and both PI & PD groups of researchers that would require further investigation and indicate a difference in the experience of payload operations for a particular subset of the researcher community.
3. Determine the nature of the ratings distributions for each of the identified issues.
4. Identify characteristics that indicate the qualitative aspects of the respondents' experience.

C.1.5 Quantitative Results

C.1.5.1 Overall Level of Agreement

The overall mean rating across the entire issue set was 3.4. This exceeds the rating of 3 (somewhat agree) and indicates a high level of agreement with the set of issues. On a per-question basis, the range of mean ratings was from 3.3 to 3.7.

C.1.5.2 Rating Patterns among PI, PD, and Both Groups

There were no statistically significant differences, $F=1.01$ ($<F_{crit}=3.32$), in overall rating patterns for PIs, PDs, or both (PI/PD). The researcher subgroup a respondent belonged to did not account for their pattern of ratings. Consequently, the ratings across all three groups reflect a consistency of experience of ISS Payload Operations.

ANOVA of Researcher Groups' Ratings

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
PI	14	45.5	3.25	0.79
PD	11	39.6	3.6	0.15
Both	8	28.8	3.6	0.40

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*F crit*
Between Groups	0.99	2	0.49	1.01	3.32
Within Groups	14.64	30	0.49		
Total	15.62	32			

C.1.5.3 Nature of Ratings Distributions for Each Issue

Visual examination of the ratings distributions for each identified issue indicates a high level of agreement for each issue and issue set. While there are differences in the mean ratings, all rating distributions are toward the *strongly agree* side of the rating scale on all questions/issues.

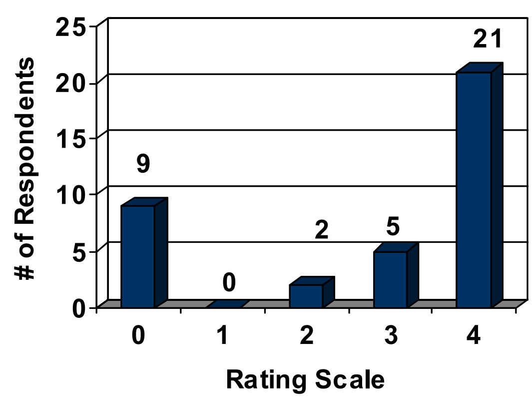
Shown below are the descriptive statistics and ratings distribution charts for each of the five questions/issues.

Question/Issue 1. Current ISS payload practices (not confined to payload operations) are resulting in a document burden on the PIs that is significantly greater than for Spacelab or other past human space missions.

The descriptive statistics summary is shown below.

Descriptive Statistics for Question/Issue #1	
Mean	3.7
Median	4
Mode	4
Standard Deviation	0.61
Range	2
Minimum	2
Maximum	4
Count (n)	28

Q1 Ratings Distribution all Respondents

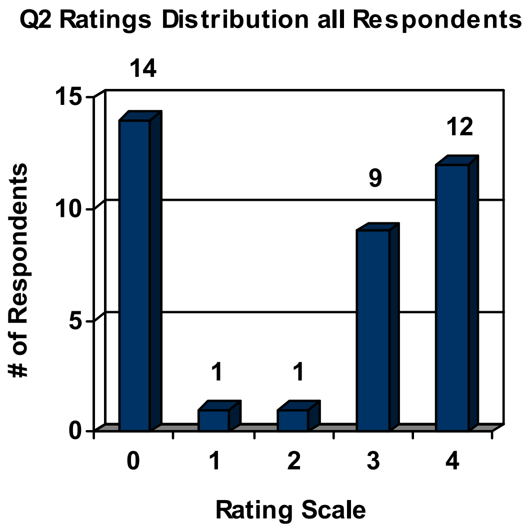


With a mean of 3.7 and a mode and median of 4 indicate that this researcher community considers the current ISS payload documentation requirements excessive. The ratings distribution chart for Question/Issue 1 (Q1 Ratings Distribution all Respondents) visually shows the overwhelming high level of agreement (21 respondents rated this item *strongly agree*, exceeding the *somewhat agree* ratings by a factor of 4) around this issue. *Seventy-five percent of the total number of respondents who had direct knowledge or experience* of the documentation requirements strongly agreed with this question/issue. The other 25 percent of the respondents (9) indicated that they had no direct knowledge or experience of the ISS payload documentation practices on which to base a response.

Question/Issue 2. The ISS Payload Data Library requires excessive researcher effort to maintain and is not always used by the NASA Payload Operations personnel.

The mean rating of 3.4 indicates that there is more than "some" agreement on the maintenance effort required on the part of the researcher and use of the PDL by NASA during payload operations. The descriptive statistics summary is shown below.

Descriptive Statistics for Question/Issue #2	
Mean	3.4
Median	4
Mode	4
Standard Deviation	0.79
Range	3
Minimum	1
Maximum	4
Count (n)	23

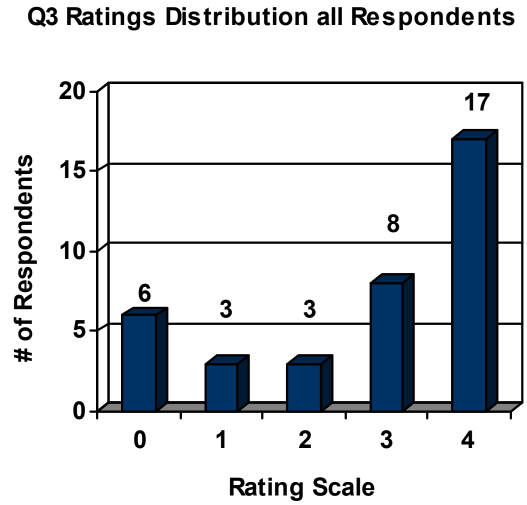


The chart showing the distribution of the respondent ratings (Q2 Ratings Distribution all Respondents) indicates that *38 percent of all the respondents have no direct experience or knowledge* about the PDL and its requirements. This is the largest number of respondents to any of the questions that indicated an absence of experience or knowledge (the next largest number is 9 for Question 1, 8 for Question 5 and then 6 each for Questions 3 and 4.). This number of PIs/PDs who have no direct knowledge of the PDL coupled with the number of researchers who have no direct knowledge/experience with the documentation requirements could indicate there is another research community subgroup that may need to be addressed and included.

The remaining *62 percent of the respondents* (23) with direct knowledge/experience with the PDL, 21 respondents indicate that there is an issue between the level of effort required to maintain it and its use by NASA during operations. In looking at this result, we were directed to the September 2001 report on the customer satisfaction data with version 13.2 software package of the PDL. That survey showed high level of user satisfaction with the revised software program. Conversation with the author of PDL version 13.2 user survey indicated that there is no conflict between his finding and this one. The questions in the 13.2 user survey addressed the user friendliness of the revised software. The question/issue addressed here is not examining the software, but the overall value of the PDL in enabling research to be accomplished.

Question/Issue 3. ISS Payload operations planning and execution practices enforce adherence to standards and programmatic requirements to unnecessary degree.

Descriptive Statistics for Question/Issue #3	
Mean	3.3
Median	4
Mode	4
Standard Deviation	0.99
Range	3
Minimum	1
Maximum	4
Count (n)	31

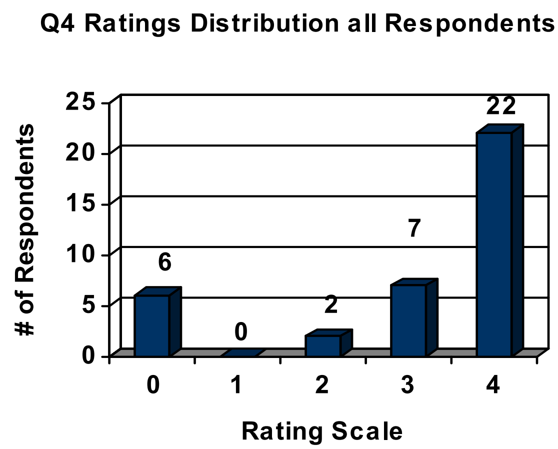


The 3.3 mean rating on this question/issue coupled with the 17 respondents who rated this item "4" and the 8 respondents who rated it "3" (*representing 80 percent of the 31 respondents who rated this question/issue*) fully validates that the enforcement of standards and programmatic requirements appears to the researcher community to be overdone.

This question/issue, along with Question/Issues 4 and 5, had the highest number of total respondents (*n*). Eighty-one percent of the respondents had the direct knowledge/experience to rate this question. The rating distribution chart (Q3 Ratings Distribution all Respondents) continues to show the ratings weighted toward the agreement end of the scale.

Question/Issue #4. ISS Payload operations planning and execution practices are overly formalized with multiple approval levels

Descriptive Statistics for Question/Issue #4	
Mean	3.6
Median	4
Mode	4
Standard Deviation	0.61
Range	2
Minimum	2
Maximum	4
Count (n)	31



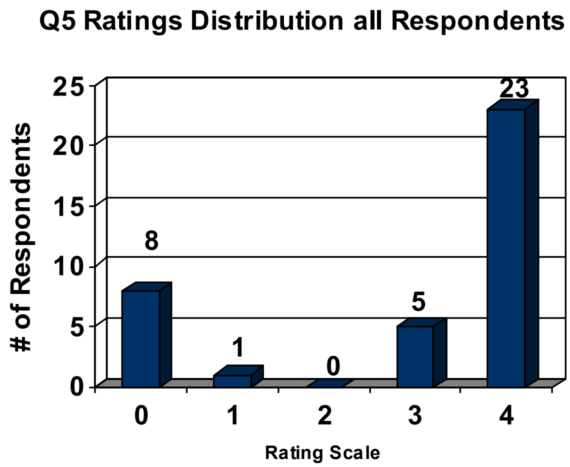
The table below shows the descriptive statistics for this question/issue. High levels of agreement are clear with a mean rating of 3.6 and a mode and median of "4". As with Question/Issue 3, the respondents who rated this question/issue represent 80 percent of the total number of respondents (31 of 37).

The graph, Q4 ratings Distribution all Respondents, shows the number of respondents rating this question/issue a "4", *strongly agree*, exceeds those who rated it a "3", *somewhat agree* by a factor of 3. The number and level of approvals from the researchers' perspective are far too formal and too many

Question/Issue 5. Multiple changes in interpretation of requirements for developing ISS crew flight procedures increase researcher workload unnecessarily.

This issue was also carried a mean rating of 3.7 with over 23 of the respondents rating this question “4”, *strongly agree*. A mode and median at “4” further supports the strength of the respondents’ ratings.

Descriptive Statistics for Question/Issue #5	
Mean	3.7
Median	4
Mode	4
Standard Deviation	0.64
Range	3
Minimum	1
Maximum	4
Count (n)	29



The ratings distribution pattern shown in the chart below, Q5 Ratings Distribution all Respondents, maintains the direction and is consistent with the ratings to the other questions.

C.1.6 Qualitative Results

Qualitative results were identified through thematic analysis of the content of the respondents’ comments. Over 79 comments were received from 23 respondents. An additional 20 comments were received from 5 associates of the invited respondents. These comments were included in the analysis. A total of 96 comments had substantive content.

Distinct characteristics of the responses included the following:

- Directness of content in terms of identifying situations, systems, processes, and issues that were seen as inhibiting research flight, execution and success and in terms of recommending potential fixes.
- A high level of frustration as illustrated by the comment: “To be honest, it is my sincere hope that I never work for another NASA manned space flight program…”
- A sense that NASA is relearning and not capitalizing on payload operations lessons that were previously learned on Space lab, Shuttle, MIR, and SpaceHab.

C.1.6.1 Overall Themes

The following are the overall themes identified in the researcher comments:

- Drastically simplify ISS documentation requirements on the order of Spacelab, Shuttle, SpaceHab, and MIR requirements. Account for payload reflight that have minimal changes to payload hardware, procedures, content. Reuse existing documentation and documentation from existing sources as much as possible and eliminate conflicts and duplication between functions, programs, and Centers. Bring documentation requirements into line with actual practices/policies of granting waivers and “grand fathering” payloads where appropriate

- The PDL needs to become even simpler to facilitate rapid flight and reflight. Despite the PDL, duplicative, paper-based documentation is often still required. NASA must increase its use of the PDL during operations. PDL is not relevant to life science research and has been waived for some education payloads.
- Standards and programmatic requirements are not focused on researcher needs. Simple experiments must conform to standards and requirements that were designed for the most complex experiments. Experiments that are being reflown are treated programmatically and unnecessarily as first-flight payloads. Specific programmatic requirements related to planning, and timelining are over emphasized and worked in the preflight phase and the products change so rapidly during operations phase that the effort expended in preflight was not worthwhile.
- Lack of direct interaction with the crew puts some payloads at risk. Approval levels and requirements frequently waste valuable researcher-crew time and delays timely execution of an experimental protocol
- There is a strong need for standardized crew procedure development guidance and requirements, for researcher review of final procedures and flexibility in accessing the crew to update a procedure as a consequence of real-time schedule and program changes.
- Customer (researcher) service by the POIC cadre during real-time testing and operations is excellent and accommodating. Such a level of customer service is not pervasive in other elements of the program to include LIS representatives not viewing their function as the focal point for payload information flow, the need for a designated “project coordinator” to interface with the researcher to avoid having too many people making duplicative information requests of the researcher, the splintering in the ISS program with regard to integration and operations.

C.1.6.2 Comment Distribution by Researcher Group

The table below indicates the substantive comment volume by question by researcher group. The greatest number of comments (47) were made by the payload developers suggesting that they have more direct contact with the NASA payloads processes than the PIs might have, particularly some of those who are in the life sciences research discipline and who indicated that they are somewhat more “shielded” from these processes.

Number of Substantive Comments provided by Question by Researcher Group						
Researcher Group with Total number of respondents indicated in Parentheses	**Question 1** 1. Current ISS payload practices (not confined to payload operations) are resulting in a document burden on the Principal Investigators that is significantly greater than for Spacelab or other past human space missions.	**Question 2** 2. The ISS Payload Data Library requires excessive researcher effort to maintain and is not always used by the NASA Payload Operations personnel	**Question 3** 3. ISS Payload operations planning and execution practices enforce adherence to standards and programmatic requirements to an unnecessary degree	**Question 4** 4. ISS Payload operations planning and execution practices are overly formalized with multiple approval levels	**Question 5** 5. Multiple changes in interpretation of requirements for developing ISS crew flight procedures increase researcher workload unnecessarily	**Total Number of Comments by Group**
PI (18)	5	5	5	5	7	27
PD (11 + 5	10	10	9	9	9	47

Number of Substantive Comments provided by Question by Researcher Group						
Additional Inputs)						
Both PI//PD (8)	5	4	4	4	5	22
Column Totals	20	19	18	18	21	96

Appendix C
Part 2. Survey Questionnaire

Dear Colleague,

As Research Manager for the International Space Station, as well as a former space researcher like you, I am asking your help in answering the five-question survey included below. I too receive n emails per day, where n is a large number. However, this questionnaire will only take 5-10 minutes and your response will be extremely valuable in improving your research experience on ISS in the future.

Please reply no later than Friday, 21 December 2001. If you fill it out right now, the pain will be quickly over!

Thanking you in advance,

Dr. John-David F. Bartoe

ISS Research Manager

Researcher Survey of ISS Payload Operations Planning and Execution

Background: NASA's Office of Biological and Physical research is studying the current ISS approach to payload operations planning and execution in order to make process improvements and cost reductions. The Study Team has identified five potential payload operations issues of concern to researchers and payload developers like you that could help target improvements. We are interested in determining your level of agreement on these five issues, identifying any additional issues, and gathering your recommendations on how to address them.

Instructions: Please complete the following short questionnaire and simply return it by e-mail reply. Please do not let the negative form of the statements influence your answer; we want your personal opinion. Your feedback will be held in confidence.

For each issue, using the scale below, please enter the number in the space provided between the ( )'s that indicates your level of agreement with the statement. Any additional comments or recommendations you might have are very welcome. There are no space limitations.

Scale:

1 = Strongly Disagree
2 = Somewhat Disagree
3 = Somewhat Agree
4 = Strongly Agree
0 = Insufficient direct knowledge or experience on which to base a response.

If you use this choice, please explain why.

The Study Team has identified the following five issues:

(   ) 1. Current ISS payload practices (not confined to payload operations) are resulting in a document burden on the Principle Investigators that is significantly greater than for Spacelab or other past human space missions.

Comment/recommendation:

(   ) 2. The ISS Payload Data Library requires excessive researcher effort to maintain and is not always used by the NASA Payload Operations personnel.

Comment/recommendation:

(   ) 3. ISS Payload operations planning and execution practices enforce adherence to standards and programmatic requirements to an unnecessary degree.

Comment/recommendation:

(   ) 4. ISS Payload operations planning and execution practices are overly formalized with multiple approval levels.

Comment/recommendation:

(   ) 5. Multiple changes in interpretation of requirements for developing ISS crew flight procedures increase researcher workload unnecessarily.

Comment/recommendation:

Appendix C
Part 3. Survey Addressees

PIs and PDs on ISS thru Expedition 6
As Used for Survey by POCAAS

ADF (Avian Development Facility)

Principal Investigators

J. David Dickman
Development and Function of the Avian Otolith System in Normal and Altered Gravity Environments
Washington University

Stephen Doty
Skeletal Development in Embryonic Quail
Hospital for Special Surgery

Payload Developer

E-Randall Berthold
Ames Research Center

ADVASC (Advanced Astroculture - Microgravity Impact on Plant Seed-to-Seed Production)

Principal Investigator/Payload Developer

E-Weijia Zhou
Wisconsin Center for Space Automation and Robotics,
University of Wisconsin - Madison

APCF (Advanced Protein Crystallization Facility)*

Principal Investigator/Payload Developer

E-Pasquale DiPalermo
European Space Agency

ARIS-ICE (Characterizing the Active Rack Isolation System)

Principal Investigator

E-Glenn Bushnell
The Boeing Company, Seattle

Payload Developer

E-James Allen
The Boeing Company, Houston

Project Manager

Naveed Quraishi
Johnson Space Center

BBND (Bonner Ball Neutron Detector)

Principal Investigator/Payload Developer

E-Tateo Goka
National Space Development
Agency of Japan

BPS (Biomass Processing System)

Principal Investigators

Tom Crabb
Orbital Technology Corp.

Payload Developer

E-Randall Berthold
Ames Research Center

Photosynthesis Experiment and System Testing Operation Gary Stutte
Dynamac Corporation**CBOSS (Cell Biotechnology Operations Support Systems)**

Principal Investigators

Jeanne Becker
Evaluation of Ovarian Tumor Cell Growth and Gene Expression
University of South Florida

Payload Developer

E-Neal Pellis
Johnson Space Center

Renal Cell Differentiation and Hormone Production from Human Renal Cortical Cells

E-Timothy Hammond
Tulane University Medical Center

Use of NASA Bioreactor to Study Cell Cycle Regulation Mechanisms of Colon Carcinoma Metastasis in Microgravity

J. Milburn Jessup
University of Texas Health Science Center, San Antonio

PC12 Pheochromocytoma Cells: A Proven Model System for Optimizing 3-D Cell Culture Biotechnology in Space

E-Peter Lelkes
Drexel University

Production of Recombinant Human Erythropoietin by Mammalian Cells Cultured in Simulated Microgravity

Arthur Sytkowski
Harvard Medical School

Simulated Microgravity Antigen Synthesis in Tonsillar B Cells

Joshua Zimmerberg
National Institutes of Health

CBTM (Commercial Biotechnology Module)

Payload Developer and PI Interface

E-Ted Bateman
BioServe

CEO (Crew Earth Observations)

Principal Investigator

E-Kamlesh Lulla
Johnson Space Center

CGBA (Commercial Generic Bioprocessing Apparatus) STS 106 sortie

Principal Investigators

E-Timothy Hammond
Neurolab Reflight
Tulane University Medical Center

Payload Developer

E-Louis Stodieck
BioServe Space Technologies

Effects of Spaceflight of Drosophila Neural Development

Haig Keshishian
Yale University

CGBA (Commercial Generic Bioprocessing Apparatus) Increment 2, 4, and 5

Payload Developer and PI Interface

David Klaus
BioServe Space Technologies, Boulder

CPCG (Commercial Protein Crystal Apparatus) *

Principal Investigator

E-Larry DeLucas
University of Alabama, Birmingham

Payload Developer

Dan Connor
University of Alabama, Birmingham

CSLM-II (Coarsening in Solid-Liquid Mixtures II)

Principal Investigator

Peter Voorhees
Northwestern University

Payload Developer

Walter Duval
NASA-GRC

DCPCG (Dynamically Controlled Protein Crystal Growth)

Principal Investigator

E-Larry DeLucas
University of Alabama, Birmingham

Payload Developer

Tim Owen
Marshall Space Flight Center

DOSMAP (Dosimetric Mapping)

Principal Investigator

E-Gunther Reitz
DLR Institute of Aerospace Medicine

DREAMTiME (Long Duration HDTV Camcorder Experiment)

Principal Investigator

Ben Mason
Dreamtime Holdings, Inc

EarthKAM (Earth Knowledge Acquired by Middle Schools)

Principal Investigator

E-Sally Ride
University of California San Diego

Payload Developer

Brion Au
Johnson Space Center

ENTRY MONITORING (Monitoring of Heart Rate and Blood Pressure During Entry, Landing and Egress: An Index of Countermeasure Efficacy)

Principal Investigator

E-Janice Meck
NASA-JSC

EPO (Education Outreach)

Payload Developer

Patience Smith
Johnson Space Center

EPSTEIN-BARR (Space Flight Induced Reactivation of Epstein-Barr Virus)

Principal Investigator

Raymond Stowe
UTMB, Galveston

EVARM (A Study of Radiation Doses Experienced by Astronauts in EVA) Principal Investigator

Ian Thomson
Thomson & Nielson Electronics LTD, Ottawa**ER-EXPPCS (Physics of Colloids in Space)**

Principal Investigator

E-David Weitz
Harvard University

FOOT (Foot Reaction Forces During Space Flight)

Principal Investigator

E-Peter Cavanagh
Pennsylvania State University

MSG/GLIMIT (Glovebox Integrated Microgravity Isolation Technology)

Principal Investigator

Mark Whorton
Marshall Space Flight Center

Payload Developer

Ken Fernandez
NASA-MSFC

H-Reflex (Effects of Altered Gravity on Spinal Cord Excitability)

Principal Investigator

E-Doug Watt
McGill University, Montreal

HRF Rack 1 (Human Research Facility)

Facility Developer

Dennis Grounds
NASA-JSC

InSPACE (Investigating the Structure of Paramagnetic Aggregates from Colloidal Emulsions)

Principal Investigator

Alice Gast
Stanford University

Interactions (Crewmember and Crew-Ground Interactions During ISS Missions)

Principal Investigator

E-Nick Kanas
University of California and
Veterans Affairs Medical Center

MACE-II (Middeck Active Control Experiment-Reflight Program) *

Principal Investigator/ Payload Developer

E-Rory Ninneman
Air Force Research Laboratory, Albuquerque

NASA Interface

Capt Tom Hoge
US Air Force / DoD Space Test Program

MAMS (Microgravity Acceleration Measurement System)

Principal Investigator

E-Richard DeLombard
Glenn Research Center

MIDODRINE (Test of Midodrine as a Countermeasure against Postflight Orthostatic Hypotension)

Principal Investigator

E-Janice Meck
NASA-JSC

MISSE (Materials on International Space Station Experiment)*

Principal Investigator/ Payload Developer

E-William Kinard
Langley Research Center

NASA Interface

Capt Steve McGrath
US Air Force / DoD Space Test Program

MOBILITY (Promoting Sensorimotor Response Generalizability: A Countermeasure to Mitigate Locomotor Dysfunction After Long-Duration Space Flight)

Principal Investigator

E-Jacob Bloomberg
NASA-JSC

MEPS (Microencapsulation Electrostatic Processing System)

Payload Developer and Principal Investigator

E-Dr. Dennis Morrison
Johnson Space Center

MSG (Microgravity Sciences Glovebox)

Payload Developer
E-Charles Baugher
Marshall Space Flight Center

Phantom Torso (Organ Dose Measurements Using a Phantom Torso)

Principal Investigator

Gautam Badhwar-deceased
Johnson Space Center

New Principal Investigator

E-Frank Cucinotta

PGBA (Plant Generic Bioprocessing Apparatus)

Payload Developer
Louis Stodieck

BioServe Space Technologies

Principal Investigators

Alex Hoehn
BioServe Space Technologies

STES (Protein Crystal Growth-Single locker Thermal Enclosure System)*

Principal Investigators

E-Dan Carter
New Century Pharmaceuticals, Huntsville
Facility-Based Hardware Science and Applications

Payload Developer

E-James Branas
Marshall Space Flight Center

Improved Diffraction Quality of Crystals

E-Craig Kundrot
Marshall Space Flight Center

Vapor Equilibration Studies

Aniruddha Achari
Marshall Space Flight Center

EGN (Protein Crystal Growth-Enhanced Gaseous Nitrogen Dewar) *

Principal Investigator

E-Alex McPherson
University of California Irvine

MSG/PFMI (Pore Formation and Mobility Investigation)

Principal Investigator

Richard Grugel
USRA/Marshall Space Flight Center

Payload Developer

Linda Jeter
NASA-MSFC

PUFF (The Effects of EVA and Long-term Exposure to Microgravity on Pulmonary Function)

Principal Investigator

E-John West
University of California San Diego

Renal Stone (Renal Stone Risk During Space Flight: Assessment and Countermeasure Validation)

Principal Investigator

E-Peggy Whitson
Johnson Space Center

SAMS (Space Acceleration Measurement System II)

Principal Investigator

E-Richard DeLombard
Glenn Research Center

SEEDS (Soybean and Corn Seed Germination in Space)

Principal Investigator/Payload Developer

Howard Levine
Dynamac Corporation

MSG/SUBSA (Solidification Using a Baffle in Sealed Ampoules)

Principal Investigator

E-Aleksander Ostrogorsky
Rochester Polytechnic Institute

Payload Developer

Linda Jeter
NASA-MSFC

Stelsys I (Commercial/Proprietary Investigation)

Payload Developer

Thomas J. Goodwin, M.A.
Johnson Space Center

Principal Investigator

Albert Li , Ph.D.
Stelsys, Inc.

Subregional Bone (Sub-regional Assessment of Bone Loss in the Axial Skeleton in Long-Term Space Flight)

Principal Investigator

E-Thomas Lang
University of California San Francisco

Xenon1 (Effect of Microgravity on the Peripheral Subcutaneous Veno-Arteriolar Reflex in Humans)

Principal Investigator

Anders Gabrielsen
National University Hospital,
Copenhagen

ZCG (Zeolite Crystal Growth)

Principal Investigator

E-Al Sacco
CAMMP, Northeastern University

Payload Developer

Nurcan Bac
CAMMP, Northeastern University

Appendix C
Part 4. Compilation of Comments from Survey

The following comments have been edited for clarity. The numbering scheme does not imply any priority, sequence, or respondent.

Question 1. Current ISS payload practices (not confined to payload operations) are resulting in a document burden on the Principle Investigators that is significantly greater than for Spacelab or other past human space missions.

Comments

1.1 "Compared with Shuttle/Mir the computer software design process and training approval process-differing standards at JSC & MSFC, competing committee structures, changing requirements-are more cumbersome & frustrating"

1.2 "…Ratings based on education's experience with Shuttle world."

1.3 "…Major factor regarding burden is that NASA does not have a coordinator and there are a hundred people asking for info…Have a project coordinator for each project."

1.4 "…it is also significantly greater than mid-deck payload…ISS…requirements can be trimmed"

1.5 "…several of the same mistakes that occurred in Spacelab integration happened again…development lack of steady funding results in loss of personnel, starts & stops, unnecessary delays…verification for non-critical requirements is ridiculous….PD & integrator chases documentation for requirements that are not critical to mission success...time line for submitting data...based on when data is needed for stage analyses buildup not where PD is in their hardware development...ISS documentation is becoming pretty good...MPV needs to be fixed or replaced - not user friendly...as a PD I want to report to a single person...EPIMS were helpful, role needs to be expanded into POIF...POIWGs need to become more like old POWG for Spacelab"

1.6 "…Payload XYZ is a very simple, low overhead payload…current station practices have the PIs going to the PDL for the integration agreement, PVP/ICD then to the iURC for resource requirements (again)…how about "one-stop" service eliminating the split between JSC-OZ & MSFC-POIC?"

1.7 "…the current ISS document burden is greater than for Spacelab…it is greater than it needs to be…Some interface requirements are redundant or have conflicting verification requirements…some interface requirements have been put on the PDs that should be the responsibility of the rack administrators...PDs are required to provide the same info/data to multiple documents or databases"

1.8 "...number of POCs & databases is overwhelming to stay current & keep updated…have to have a detailed understanding of MSFC processes and systems…used to have an integration engineer for ops to serve as a single POC to assist w/overall process…"

1.9 “I have only been involved in the Spacelab ___ mission and currently an ISS experiment. Both experiments are pre/post flight with no in-flight portions…the amount of documentation for these experiments has not changed much…I have not been involved with in-flight experiments...”

1.10 “…I have been developing & successfully flying experiments/payloads since 1974 and have never seem it this bad nor as confusing as it is with Payload ops planning & mass confusion with the MSFC as the middleman…We should do business the way Spacehab does...got the job done, with competent people and good help instead of endless process, unreasonable attitudes & chaos.. It now takes 2.6 times more support personnel & cost to REFLY a payload on ISS-Express rack than it cost to develop the original payload & fly it on Shuttle or Spacehab...the unnecessary documentation is not the only issue...Totally eliminate MSFC/Boeing/TBE from payload operations & management support of ISS, cut the total budget by 75 percent & use the funds now being wasted at MSFC to fund bare minimum payload support efforts at KSC & JSC...”

1.11 “JSC human life sciences (Code SF) have a team of people who to some extent "shield" the investigators from the full horror of the ISS paperwork…”

1.12 “Audit & scrub ISS requirements against equivalent Spacelab documentation…pay particular attention to human factors requirements and displays…the documentation has to be re-released or revalidated for each increment even… if the payload is flying without modification or change...”

1.13 “I had absolutely no interaction with the development of documents for the ISS Payload..”

1.14 “Spacelab had an established system and a clear integration process with established integration contractor responsibility. The ISS process has been a work in process with parallel development of early payloads at the same time as the development of ISS utilization capabilities and processes. Many PIRNs are generated by ISS as a result, requiring considerable effort by the PDs to review and respond to potential impacts. The integration process itself evolved and was a moving target”

1.15 “We were a re-flight experiment, having previously flown on STS-XX and we were put through the ringer to fly on ISS. Many of the specs were ludicrous and in the end were waivered after much wailing and gnashing of teeth.”

1.16 “Should refer to Spacehab research missions instead of Spacelab since it is no longer in existence. It is almost impossible to design and develop experiment hardware in parallel with facility/vehicle requirements that are currently being developed or constantly changing. Experiment development teams must therefore devote extensive resources to assess and implement the requirement changes, yet, the ISS program has no mechanism or policy to augment or fund the developer when requirement changes force changes to the experiment. The ISS program with respect to experiment integration and experiment operations is very splintered. To fly an experiment on ISS, a PI/PD team must interface with so many different organizations, it is very easy to get lost in all the requirements, guidelines, schedules, and deliveries. Recommendation: develop an end-to-end user manual for PI/PD teams to fly experiments on ISS.”

1.17 “Needs to be a reassessment in PDL content for data required to fly a payload…”

1.18 “Duplication of data needs to be kept minimal…introduces too much room for error”

1.19 “Reduce the duplicate data inputs. Too many people are asking for the same information and then when it needs updating it is hard to remember who asked for this info and the same old info may exist elsewhere”

1.20 “Payload XYZ was the first payload with which I have worked”

1.21 “…PD is required to enter identical information in multiple places or via e-mail per the request of different groups…there should be one place to enter data…different groups request data in different formats…we spend a lot of time inputting data in different places, but it does not seem that the majority of this data is even used by the program...”

Question 2. The ISS Payload Data Library requires excessive researcher effort to maintain and is not always used by the NASA Payload Operations personnel.

Comments

2.1 “As PI I do not see this PDL at all”

2.2 ”A mild irritant at first-people were responsive and we worked out the kinks”

2.3 “…Education has dispensation from using PDL at this time”

2.4 “By the time one understands how PDL works & where the info is, the hardware is back from the mission”

2.5 “PDL needs to be modified to be user friendly to the PD…PD should not have to enter same info 2x…concept is good implementation of PD side fails…interface should have a single input area…and why is the PD required to enter info like KSC requirements into the system when KSC does not use the system...Two systems cost money that could be used for research!”

2.6 “Bluntly, this is true statement. PDL & iURC data does not flow to all NASA ISS resource controllers…”

2.7 “PDL is well organized…excessive effort to use is caused by the organization of PDL data by flight or increment…since many payloads will operate over several flights organize PDL forms so that launch and return flights are identified and all on-orbit data entered once in the applicable forms that would apply to all flights and increments between launch and return...my impression is that the PDL is referenced very little or not at all during real-time operations...”

2.8 “I do not have primary responsibility for PDL management. Although I understand that it is rather tedious & time consuming…”

2.9 “True, most of the time the payload Operations personnel say they need to information still require separate paper copies of procedures, Cof Cs, drawings, etc…be submitted directly to them…The PDL should be kept only for final document reference, not as the document control mechanism for all changes that occur for the entire 24 months prior to flight. If the documentation for the next flight of the same payload is required there should be a simple way to import the entire PDL file from the previous flight without having to start new submissions all over again just because it is a new increment...”

2.10 “Dealing with the PDL is a nasty experience. This database is poorly suited to life sciences research and seems largely a MSFC invention…the PDL does not really apply (to Life sciences) anyway…principal issue with the PDL is the seeming total inflexibility…we worked around a bug in our downlink spec because fixing it would have required a change to the PDL...”

2.11 “Significant amounts of info in the PDL are not utilized by the program…”

2.12 “I only recently became aware that the PDL existed and I certainly have not utilized it or had any experience with it whatsoever”

2.13 “The potential value for the PDL was to establish a database of payload information that can be shared and used throughout the program without asking the PDs to make multiple inputs. The potential has not been realized”

2.14 “The concept of an electronic database is a great idea but the current system is not PI/PD friendly and often lags significantly behind the continuously changing Program/Vehicle requirements. The library system should be a fixed database for an experiment much like the PIP and annexes systems the Shuttle has used for years. Whenever a P/L is manifested the program should draw from this datafile. For payloads that will fly many times it would be better to have the information by payload then the particular information needed for an increment/flight could be pulled out of this. This would reduce the PD's need to re-enter/copy data for every flight/increment.”

2.15 “…Fastest way for ISS personnel to get info is to go to PD direct via e-mail, not the PDL”

2.16 “PDs constantly tracking data in PDL data assets to make sure it is up-to-date…When NASA personnel are not using the PDL…”

2.17 “For payloads that fly many times, it would be better to have information by payload then the particular info needed for an increment/flight could be pulled from this…”

2.18 “PDL appears to be utilized as a pre-mission tool & is not given great emphasis when dealing with real-time responses to issues…”

2.19 “Get a consensus of what data the PD should be inputting & where..”

Question 3. ISS Payload operations planning and execution practices enforce adherence to standards and programmatic requirements to unnecessary degree.

Comments

3.1 “The problem is not really adherence. The content of the standards and programmatic requirements are not focused on the needs of the investigators. The problem pervades the whole program”

3.2 “Scheduling training sessions are difficult & they are often not firm until a week before the date….makes planning trips difficult, raises airline travel fares”

3.3 “Direct interaction with the PI should occur much earlier”

3.4 “…and the standards are not easily traceable”

3.5 “…our experience has been that payloads consistently take a back seat to operational requirements… Payload XYZ would not have received its required run time had it not been for the crew working during their time off… Payload XYZ flying attitude detrimental to its science”

3.6 “Realtime ops-major problem is inability of program/cadre to understand and accept that most payloads are not on console 24-7 & not physically located within HOSC…NASA has supported idea of telescience but has not the practical implementation of it…no reliable mechanism for payloads to stay informed of events & decisions that occur while they are off console...applications &tools are not accessible to everyone...simple things like crew procedures & OCRs aren't accessible unless sitting on console...LIS reps do not view their function as the focal point for payload/cadre information flow...”

3.7 “Working with limited crew time/vehicle resources make this necessary…this is one of the major reasons for success achieved in early increments…”

3.8 “…for pre-flight operations planning this is true…support from POIC cadre for on-orbit testing has been excellent and accommodating”

3.9 “…process seems to require "simple to operate" experiments conform to integration processes that may be appropriate for complex, interactive experiments…system may not adequately support the needs of these complex research protocols…Perhaps one size does not fit all”

3.10 “This is especially difficult when IDD & reporting requirements are constantly changing…change the Payload ops philosophy that if a payload has been flown before it makes no difference…therefore it must be redesigned, rebuilt, etc….Treating the individual payloads with the same requirements as an ISS core or express rack facility should be reevaluated and eliminated...Have a simple set of interface requirements for payloads that were previously flown...”

3.11 “This is particularly true in the execution practices area….even the simplest changes to plans & procedures require full formal reviews & approval prior to implementation, normally at a cost of not getting the work accomplished until days later if at all...”

3.12 “I was unable to make the appropriate experimental changes to accommodate for the extreme delay in return of payload cell samples…from the station….allow the investigator greater access to absolute cut-off timelines for experiment protocol modification, based on flight scheduling delays, so that modifications in planning as well as programmatic issues could be more easily dealt with...”

3.13 “The pre-flight timeline efforts were ineffective and artificially constrained command and telemetry capabilities possibly due to a lack of understanding of ISS/Express performance, KU band availability, Ethernet communications performance limits, etc. AOS/LOS predictions were unreliable and AOS coverage was "ratty", requiring multiple re-requests for telemetry...this contributed to the ineffectiveness of the planning practices and required more of a real-time implementation”

3.14 “In our case, planning was worthless as we rarely knew when we would fly and there was zero opportunity for the technical people to be in Houston to support ops and troubleshoot when problems occurred. In addition, being unable to actually train the astronauts resulted in several problems that resulted in corrupted or useless data”

3.15 “Consolidate”

3.16 “ISS Planning & execution team are flexible & work situations on case-by-case basis…”

3.17 “Retrospectively, I would agree, however going into a mission I am not confident that I would say that all unused practices were unnecessary…”

3.18 “At times, the cadre will not ask the crew a question & the PD and cadre end up spending days & weeks on a task that a crewmember could answer in less than 5 minutes”

Question 4. ISS Payload operations planning and execution practices are overly formalized with multiple approval levels.

Comments

4.1 “The question posed requires the investigator to penetrate the NASA organizational system; it would be better to ask investigators questions in terms of the end results of NASA’s processes.”

4.2 “Compared with Shuttle/Mir the computer software design process and training approval process-differing standards at JSC & MSFC, competing committee structures, changing requirements-are more cumbersome & frustrating”

4.3 “Too many operators & too few PD's”

4.4 “Currently OCR must be submitted before discussions w/flight controller…discussion before submission would ease the process…multiple levels contribute to misinterpretation and deletion of valid requirements…”

4.5 “ISS should be used as a research lab…PDs should have access to people doing the work…crew should not be inaccessible…”

4.6 “…Payload XYZ scheduling process is getting smoother…understanding most requirements cannot be timelined until much closed to their operation, the OOS & long term planning tools provide a reasonable opportunity for success…this knowledge gained during early scheduling appears to be ignored by & the PIs/PDs go through the whole process again just prior to payload activation...my experience with execution practices is good so far...”

4.7 “I spent almost 2 years developing the ___ payload planning data set in the iURC…iURC & OOS did not originally have the flexibility to easily handle the fluid nature of actual operations…changes were very difficult to implement…significant improvements to OOS have been made...pre-flight planning is overly formalized and rigid, short-term and real-time re-planning that occurs daily is very flexible...POIC Cadre has worked very hard to accommodate operations changes requested by all payloads...”

4.8 “It’s not so much the number of approval levels as it is the number of POCs that we have to keep up with…”

4.9 “True, the way it is handled now it is endless chaos…Go back to the way payloads were handled for Spacelab, Shuttle Mid-deck & Spacehab. That system worked well….Get a team of experienced Payload developers & ISS program managers to review all current deliverables and complicated approvals with a mandate to cut 70 percent...eliminate endless telecons & practice sessions prior to required program reviews...”

4.10 “This is true in the case of timelining…the only thing about a timeline that can be relied on is that it will change…with each iteration things get worse as constraints are not met and things simply don't work…similar problems apply to preflight timelines involving training & baseline data collection. These changes constantly & the effect is devastating on the investigators...”

4.11 “Many operations practices are a hindrance to actually getting the work accomplished in a timely fashion and mean very precious crew time is wasted due to high overhead associated with planning and getting approval to execute the required work…”

4.12 “My impression here is probably yes, but even as a guest investigator, I was not made aware of all the levels of approval…”

4.13 “Expect and plan for less formal, real-time, self-regulating (such as internet/Ethernet) communications protocol…and provide separate channels as necessary for high bandwidth users to prevent conflicts with payloads that have low telemetry demands. (The purpose being to reduce/eliminate the need to timeline routine communications).”

4.14 “Thankfully, DoD STP took the brunt of this, but we still worked with their office to provide inputs.. We would seem to go round and round to the point that I was highly skeptical that we would ever fly Payload XYZ.”

4.15 “Why do MOD, SpaceHab, and ISS all have different requirements, guidelines, and formats for developing crew procedures? NASA should develop a standardized set of requirements and formats to follow so that crew procedures developed, and validate an experiment could be used on any vehicle. I understand ISS utilizes an electronic system where MOD and SpaceHab do not. Maybe MOD and SpaceHab should adopt the ISS system? The ISS delivery template should be relaxed to the stage the hardware flies on, and not the increment. Some of the requirements have no value added. Procedures go through too many hands and the PDs may not see the final product unless they ask. The process for submitting and revising procedures to the program is very complex.”

4.16 “…Processing OCRs in mid-flight is longer to approve because of # of people…”

4.17 “See comments to next question”

4.18 “When the PD submits an OCR via PIMS, the reviewers sometimes review & comment on the entire procedure instead of the documented changes.. The PD has to defend a position that has already been approved/decided upon…the process takes entirely too long, even when you give adequate lead time, some comments are submitted late...”

Question 5. Multiple changes in interpretation of requirements for developing ISS crew flight procedures increase researcher workload unnecessarily.

Comments

5.1 “The hardware I’ve been involved with is very simple and multiple changes have not been a problem. It has been a problem to get 5 minutes of crew time to do a task because the schedulers insist on treating it as a 30 min exercise”

5.2 “I agree many changes are occurring that require significant re-examination & rework by the PIs and hardware developers; I do not agree that the attention to the changes is unnecessary. Changes need to be reduced or stopped at higher levels of development”

5.3 “Compared with Shuttle/Mir the computer software design process and training approval process-differing standards at JSC & MSFC, competing committee structures, changing requirements-are more cumbersome & frustrating”

5.4 “Operation is a science is normally not known by the scientists & interpretation is not always obvious”

5.5 “Payload ops process & reviewing of procedures needs to be standardized….there were 5 reviews of Payload XYZ procedures…changes were due to differing standards”

5.6 “There seems to be too many people involved in the ‘paper work’ aspect of ISS ops…Direct contact between the science team & crew is too limited”

5.7 “This stems from the issue that we are verifying that switches throw 30 degrees (instead of 29 degrees)…the sheer number of verifications, the endless modifying becomes overwhelming…safety verifications should be the only requirements that are not grandfathered...”

5.8 “Strong requirements re payload procedures up front would save a lot of PI/PD frustration just prior to payload start-up…POIC personnel do not review procedures early enough to allow changes to be made in a careful & productive environment…lesson learned: develop procedures from start to finish & then break them into smaller groups...”

5.9 “The system should be revised to enhance the prospects for research & minimize the difficulty in accomplishing the stated goals of the research, changes to experimentation should be viewed, as much as possible, as a matter of course, not the end of the world”

5.10 “To date, our flight experiment has not flown on ISS, the process has worked very well for us.”

5.11 “…program (needs) to settle on the requirements & establish a consistent interpretation of procedure development requirements (then this problem goes away)…the crew procedure review process ____ underwent 2 years ago was very time consuming and difficult...a level of detail was required that made it difficult to get final approval...some of the detail turned out to be unnecessary - crew didn't need it...the review process during real-time ops has been much easier to work with...”

5.12 “Responsibility of detailed procedure formatting to the ISS specs was originally placed on developers. This function was later added by the PODF, but the budget ran out. Currently, we now do the initial development & formatting, MSFC does a final scrub”

5.13 “This is especially a waste of time & a large unnecessary cost…having to revise a two page crew payload procedure 76 times for ISS that was successfully used on STS-XX is ridiculous…eliminate MSFC training teams & allow payload developers to interface direct with crew training personnel & training sessions at JSC...Have a JSC flight crew procedures team work direct with the PD to develop crew procedures...Publish a standard reference document for PDs to develop crew procedures then don't change it for at least 24 months...Overall: eliminate MSFC/Boeing/TBE as the unnecessary middlemen in ISS payload processing...POIC should be eliminated...PDL should be a library finalized only within 60 days of flight...Revised and simplify the process for developing crew procedures”

5.14 “The entire procedure development & training process has far too many people involved…we submit procedures that work, have been seen by the crew & then are changed (butchered)…investigators are forced to dry run training sessions to avoid wasting crew time doubling the time to do a training session...trying to get a simple in-flight procedure was an exercise in idiocy with numerous procedure people changing our words without actually knowing what they were dealing with. Not a good experience”

5.15 “This is definitely true although it has been improving some. There is still inconsistency in interpretation based on the individual doing the evaluation of a product, but the range of inconsistency is narrowing…”

5.16 “I had no interaction with any issue relating to flight crew procedures…”

5.17 “ISS and STS procedures should be controlled in like manner. Commonality should allow the ISS program to use existing PD procedures from STS flown payloads in the development of procedures for ISS. The Payload Display Review panel & processes for crew procedures review is unnecessarily subjective even prior to crew involvement. The panels seem to make firm judgement calls on behalf of the crew that may not represent a hard crew preference. These panels can significantly and possibly unnecessarily impact PD development programs by these decisions.”

5.18 “Not only multiple changes in interpretations, but that fact that different members of the payload staff had differing opinions as to what the requirements really meant. Also being ‘crapped’ on because we did not meet a formatting requirement when no formal requirement existed (had not been approved) drove us nuts as we reformatted information that did not change just so a ‘bean counter’ could feel good about the fact that they had hassled an experimenter. Being naive, I assumed that people in the payload office would be more supportive and helpful instead of throwing up road block after road block doing their best to hinder any forward progress on our program. To be honest, it is my sincere hope that I never work another NASA manned space flight program. On a positive note, there were certain individuals that were absolutely fabulous in their support and enthusiasm. However, they were few and far between.”

5.19 “procedures regarding displays are hard to develop due to changes by the PDRP…procedures without displays are simpler to write..”

5.20 “Changes in interpretation of procedure requirements occur often and seem unnecessary…overall procedure seems too complex…goes through too many channels”

5.21 “Some requirements have no value-added. Procedures go through too many hands & the PD may not see the final product unless they ask…The process for submitting & revising procedures to the program is way too complex…”

5.22 “I am not sure how you can achieve (actual accountable) control without being formal. However, considering the latter ‘have too many approval levels’ I would respond…that…there are too many areas of responsibility that are affected by a single payload’s operations & each of these areas should have the opportunity to comment on a particular operating procedure. But then each are has its own approval hierarchy...so here I would encourage a reduction...rubber stamping is not necessarily value-added if there is not actual participation by that individual...”

Appendix D. Examples of Excessive ISS Requirements

Background

The POCAAS Study Team has been tasked with finding mechanisms to decrease the cost of payload operations on ISS. During the course of that study, it became apparent that some members of the team had been either principle investigators (PIs) or payload developers (PDs) on both Shuttle and on current payloads/experiments flying on ISS. Upon polling those PIs/PDs on the POCAAS team, it was found that there was complete agreement relative to the payload integration and payload operations on several points:

5. It takes more time, money and effort to fly an existing flight proven Shuttle payload on ISS as a re-flight payload than it costs to fly the same payload on the Shuttle. The factors among the PI's/PD's varied from a factor of 2.4 to 4.0.
6. One of the major cost drivers was in the excessive and repetitive documentation requirements imposed on ISS payloads, coupled with crew training, mission ops procedures, labeling of front panels and other items to be discussed in the body of this report.
7. The present requirements imposed on ISS payloads are excessively tighter than on Shuttle for no apparent reason.
8. The requirements drive the documentation and hence the cost.

The PIs and PDs on the POCAAS team believe that, if the requirements could be relaxed (both payload operations and payload integration) while maintaining all safety considerations, flying payloads on the ISS would be easier, quicker, and less expensive and the current massive and redundant documentation requirements would be significantly reduced.

The following requirements represent a compilation of ISS requirements from three real ISS payloads that were first flown on Shuttle missions and then either were modified to meet the new ISS requirements (e.g., rear air breathing) or were designed from the ground up for ISS. The inputs relative to the specific ISS payloads come from three veteran PIs and PDs. Larry Delucas, Al Sacco, and John Cassanto comprised the user team directly concerned with this requirement study. The technology categories encompass protein crystal growth, inorganic crystal growth, and microencapsulation of drugs and, therefore, cut across several technical disciplines and should be representative of the kinds of payloads and problems for new users planning to fly on ISS. This report details and recommends changes to various aspects of processing a payload on ISS based upon the experiences of the POCAAS user team.

The information to be presented utilizes a format which first defines the item to be discussed for example, mission ops/crew procedures, then the payload is defined, and the PI or PD identified. Then there is a discussion of the issue or problem encountered and sometimes a resolution is found, other times there is no resolution, resulting in time and money being wasted.

One final point, the POCAAS user team firmly believes that we have only scratched the surface of the top of the iceberg. We believe that an extensive study should be conducted consisting of more PIs and PDs in conjunction with the appropriate NASA personnel/contractors to take a fresh look at the existing ISS requirements with the goal of relaxing and/or eliminating *requirements so long as safety is not jeopardized. This would have the affect of reducing the cost, the time and the effort to fly a payload on ISS for the PI, the PD, and NASA.*

The following sections present actual case studies, which provide the rationale for reducing/relaxing payload operations requirements and payload integration requirements. The results are separated by payload operations examples and payload integration examples.

D.1. Payload Operations Examples

1. Item Description: Crew Procedures

Payload: MEPS

Principal Investigator: Dr. Dennis Morrison

Payload Developer: John M. Cassanto

Requirement: There will be a mission operations procedure document approved by NASA MSFC personnel.

Discussion: The crew procedure to operate the MEPS payload is a relatively simple procedure that is divided into several sections dealing with powering up, Process Control Module change out, and powering. On the STS-95 flight, John Glenn was trained to operate the hardware. The MEPS Shuttle hardware required some modifications to meet the ISS rear air breathing requirements for the UF-1 ISS mission as well as upgrading to a small computer integrated to the chassis, which made the system more compact. In addition the PCMs incorporated rear connectors that eliminated the crew from having to mate and de-mate cables for each PCM change out, which markedly reduced crew time. Figure D-1 shows the improved ISS configuration compared with the Shuttle configuration. Note that the cable from the NASA ECC computer has been eliminated and hence is one less task for the crew to mate and de-mate during a PCM change out. Funds had to be spent (for 8 months) to satisfy the crew procedure modifications imposed. We were required to make 77 revisions in 8 months. Ninety-five percent of the revisions were trivial; for example, add a space between the dashes in front of a number. The final procedure after 77 revisions in 8 months is not markedly different than the procedure that we started with from STS-95. An example of this is shown in Figure D-2, which shows the ISS PCM change out procedure. There are some extra steps in the Shuttle procedure relative to the cable, which obviously is not needed in the ISS procedure, but the procedures are essentially the same.

Recommendation. *Grandfather in procedures from previous flights (Shuttle, etc.). Allow the crew training document people to recluse themselves if the PI/PD and the crew agree at the first meeting. For new payloads, minimize the impact of the crew procedure group because it takes the PI/PD large sums of money and time to satisfy trivial requirements – see below.*

2. Item Description: Crew Procedures

Payload: CPCG

Principal Investigator: Dr. Larry Delucas

Discussion: Lack of commonality between ISS and SSP programs. UAB/CBSE flew the same malfunction and alternate procedures on both ISS and Shuttle. It is unbelievable how different they were. ISS does not recognize the SSP-formatted procedure, and vice versa. We have been flying these same procedures on Shuttle for several years, but ISS still required us to support and perform "usability certification."

Recommendation. *Grandfather in SSP payloads to fly with their existing documentation or make the ISS and SSP formats the same where applicable. Why are we reinventing the wheel?*

Discussion: Delivery dates for experiment procedures are unrealistic and jeopardize successful experiment operations. Having to submit final procedures for a re-flight experiment 7 months prior to the start of an Increment results in a costly change process.

Recommendation*: Seven months prior to the start of an increment is fine for new experiment systems but the program should have a more realistic time requirement for re-flight experiment procedures such as 3 or 4 months prior to the start of an increment.*

Discussion: There is no clear process or configuration control of experiment procedures once they are onboard.

Recommendation*: Institute a clear process for configuration control of experiment procedures onboard.*

Discussion: The Op Nom processes as well as other procedure ECR/TCM reviews are very slow.

Recommendation*: Delete some of the mandatory reviewers or tell them to pick up the pace.*

3. Item Description: Procedure Training Certification

Payload: MEPS

Principal Investigator: Dr. Dennis Morrison

Payload Developer: Mr. John M. Cassanto

Requirement: All ISS Payloads payload crew trainers will attend a course given by the MSFC to ensure that the PD/PI will train the crew in the proper manner.

Discussion: Numerous cases exist in which PIs/PDs have flown multiple missions (three or more) on the Shuttle that are re-flying similar or upgraded hardware on ISS. The PI/PD personnel that have trained Shuttle crews to operate the specific payloads are experienced and veterans of space flight operations. There is an ISS requirement that essentially states that before any person can train the crew, that person must take a course to be certified to train the payload specialist. Again, this is a waste of time and money for those PIs/PDs who have flown multiple missions. The requirement needs to be eliminated for veteran payload PIs and PDs.

Recommendation: *Eliminate this requirement for all payloads that have previously flown and trained crews (the veterans).*

4. Item Description: Payload Operations Data File and Payload Display Review

Payload: CPCG

Principal Investigator: Larry Delucas

The PODF-PDRP Payload Authorization Process states the following: "Before ISS crew operated payload equipment can be flown, the developer is required to acquire an authorization letter from the Payload Display Review Panel (PDRP) chairperson at Marshall Space Flight Center (MSFC). The authorization letter will testify to the payload's 'operability' by on-board crewmembers and grant the use of panel-reviewed procedures and displays for crew training and subsequent flight."

Discussion: The PODF-PDRP was established at MSFC to provide assistance and guidance to PDs in acquiring an authorization letter. Working together as a team that includes both the PD and Houston's Astronaut Office, the PODF-PDRP is committed to helping produce "usable" payload displays and procedures that facilitate the crew's role in obtaining anticipated on-orbit scientific results. This pamphlet will acquaint the PD with an overview of NASA's process for securing payload training and flight authorization and the role the PODF-PDRP plays in the process.

The authorization process is a disciplined process whereby a PD's displays and procedures are verified against ISS standards. They are also validated for operability via the successful completion of a "usability" evaluation that exercises the procedures and displays. The process is iterative as well as interactive, consisting of a series of display/procedure design and review activities. The authorization process identifies the following tasks as germane to the delivery of flight-ready displays and crew procedures:

- The PD develops displays and procedures per approved standards with PODF-PDRP help if requested.

  ***Recommendation**: This function should stop with display and procedures standards. Payload developers should be able to follow the standard without a NASA tutorial service.*

- PD validated displays and procedures are submitted to the PODF-PDRP for review.

  ***Recommendation**: The review process is a long and expensive luxury. This process can take months while the review panel twiddles with minutiae. Eliminate this function. If the crew cannot operate the display or application because it is unusable, then it will only hurt the PD. Therefore, the PD is motivated to follow the standard to a reasonable degree.*

- A Mini-Team appointed by the PODF-PDRP reviews the displays and procedures for standards compliance and operation issues, and then identifies any discrepancies.

  ***Recommendation**: Ditto, same as above.*

- The PD addresses the discrepancies (if any) and provides resolution.

  ***Recommendation**: Allow the PD to determine discrepancies on his/her own and correct as is reasonable.*

- A "usability" evaluation is planned, scheduled, and conducted by the Mini-Team with crew office personnel.

  ***Recommendation**: Unnecessary. Crew will have a chance to work with the display or procedure during training and any minor problems could be corrected subsequent to initial crew exposure.*

- Any impediments uncovered during the "usability" evaluation are reported to and corrected by the PD. The PDRP will help the PD in the correction activity if requested.

  ***Recommendation**: Allow the PD to self-correct. There is no need for a display police.*

- A PDRP panel then convenes and issues an authorization letter for crew training and flight.

  Recommendation*: Eliminate!* ***Further Comments****: Because the PDRP function would in essence be eliminated and replaced by a single individual who would be responsible for publishing and maintaining a standard, most costs associated with this body would also be eliminated such as*
  ** Maintaining a PODF/PDRP web site*
  ** PDRP Training Classes*
  ** Software costs for DUET and associated maintenance and personnel*
  ** Data storage costs for PD Displays that are kept on file*

Recommendation*: Greatly modify (downsize to eliminate) the MSFC Payload Authorization Process. This would save time, money, and excessive documentation and grief for the PI/PD. It would also speed up the process of getting a payload on board and save NASA money.*

5. Item Description: Payload Data Base Requirements

Payload: ZCG-FU

Principal Investigator: Al Sacco

Requirement: All ISS payload data will be submitted to the PDL.

Discussion: A lot of effort (manpower/time) gets put in for updating data into PDL. But the people who need the data don't seem to use PDL effectively. They would rather contact the PD for data. Specific example: During ZCG-FU turnover at KSC prior to UF-1, the stowage people had a hardware drawing and part number dating back to 1998 while the updated version (dated 1999) was in PDL. We had to e-mail the correct drawing again. There are a lot of redundant data in various data sets in PDL.

Recommendation*: If we are going to have a PDL, make it easier for other NASA groups and NASA contractors to obtain the data. Also mandate that all requests for payload information be obtained from the PDL. The PI/PD should be contacted only as a last resort.*

Additional PDL Considerations. PDL inputs and updates are difficult to manage. Spreadsheet information forms filled out and submitted would be easier to work for the PDs and could be setup to be transferred to the larger PDL database. There is a strong need to reduce the effort and time in supplying and updating information. With the current system, the flow down to other compiled documents is slow, causes confusion, and leads to outdated information being worked and reviewed.

6. Item Description: PODF (Payload Operations Data File)

Payload: ZCG-FU

Principal Investigator: Al Sacco

Discussion. Crew procedure standards kept changing; it's like a moving target. Procedures conforming to standards get change requests from different ISS increment crews (Example: Cases with checkmark and/or verify use, one crew member was not comfortable with the meaning of checkmark which suggests an action.)

Recommendation*: Go to guide lines while maintaining all safety considerations. Consider crew inputs, but then use common sense and explain why what the PI/PD has designed is okay and will work.*

7. Item Description: Two Centers Doing Very Similar Jobs Requirement

Payload: All

Principal Investigator: All

Discussion: There are overlaps and some conflicts between crew training teams at two centers: MSFC and JSC. One team would be sufficient. Overlaps in multiple team reviews occurs doing evaluations of labels for crew training purposes. The same topics like Payload labels are reviewed by the Marshal - PDRP = (Payload Displays Review Panel) and the IPLAT (labels team) at JSC where additional or conflicting labels requirements may surface. There is no need for two teams to be involved for this function.

Recommendation: *Pick one center to do the job. Crew training clearly should be performed at JSC because they are the most experienced.*

8. Item Description: Multiple Inputs of the Same Data

Payload: CPCG

Principal Investigator: Larry Delucas

There are many examples of the identical information being provided to different places/groups within NASA or to contractors working for NASA. Again, this defeats the purpose of making ISS easy to access and drives up the cost of flying on ISS for the PI, the PD, for both NASA-funded experiments and private sector commercially funded experiments. It is also discouraging, and it is easy to see commercial entities walking away from the microgravity opportunities on ISS.

Discussion: Within PDL we are required to input data into the EIA for each payload for each increment and for each flight.

Recommendation*: Have a Payload EIA that is not increment/flight specific.*

We also are required to input data for the ICDs and PVPs for each payload for each increment, and for each flight.

Recommendation*: Have a payload ICD and PVP that is not increment/flight-specific.*

The Manifest/Planning Groups call or e-mail PDs asking for the same information that is in the EIA. They do not look at the EIA probably because the report from PDL is not the easiest format to follow. This information will be placed into Increment Annex 5 tables of the IDRD.

No clear direction as to where data is really supposed to be input to the program. One day, PDs are asked to input ISS video requirements into PDL, then they are told to e-mail it to this person, and then they are told put the Shuttle video requirements into PDL. When PDs pointed out that the ISS requirements are no longer in PDL the Shuttle people did not know this.

COFR inputs require PDs to status items that are already being tracked by the EPIMs, but it does not matter if someone at JSC wants to see this on the COFR inputs so PDs must resubmit this.

PDs input data into PDL, iURC, OPMS, PIMS.

Recommendation: *Let's agree to have a primary NASA and/or NASA contractor point of contact for all inputs to ease the burden on the PI/PD.*

9. Item Description: Verification

Payload: CPCG

Principal Investigator: Larry Delucas

Discussion: Too many requirements have no value. As an example, originally, human factors criteria were "design to" guidelines that PDs referenced during payload development. Now they are strict requirements that must be verified by the PD teams, checked by crew office representatives, yet ignored, or disregarded because of added burden on the flight crew.

Recommendation: *Most PD teams know what requirements have little or no value and are ultimately ignored after a great deal of manpower has been expended trying to meet and verify these requirements. UAB/CBSE thinks that a requirements review including the program, RPOs, and PDs should be done to get these requirements out of the program. Other examples include specularity, acoustics, etc.*

Discussion: EXPRESS Rack Verification Data deliverables are tailored to the EXPRESS Office organizational structure and not the EXPRESS Rack Interface Definition Document in which payload interface control is documented. This results in applicability confusion during the submittal and review process.

Recommendation: *Shuttle and SpaceHab all require verification data submittals based on ICD requirement number and not discipline numbering systems. EXPRESS Rack should do the same.*

Discussion: There is a lack of coordination of teams regarding PTCS/FCU testing. The PTCS/FCU pre-test coordination communication between MSFC, the PD team, and KSC regarding testing, the required versions of databases, and availability of other support software such as EHS have been issues. PDs would like to have this process better defined and streamlined to include more communication prior to on-dock at KSC. PDs would also like to point out the necessity for testing between the PD Remote Site and MSFC prior to on-dock at KSC to work out commanding/telemetry issues prior to testing.

Recommendation: *Name a NASA lead to handle this coordination. Develop and document a well-defined and streamlined process to include more communication prior to on-dock at KSC. Provide a way to test between the PD remote site and MSFC prior to on-dock at KSC to work out commanding/telemetry issues prior to testing. Make the flight commanding, telemetry, and EHS versions available and in sync with the KSC PTCS testing schedule.*

Discussion: MSFC RPI testing prior to KSC PTCS. There is an important need to perform remote payload interface (RPI) testing with MSFC prior to PTCS testing at KSC. PDs have spoken with MSFC and they stated the main concern that prevents PDs from testing prior to PTCS on the test string is the ability to have the approximate Command and Telemetry databases for our particular flight made available at MSFC some weeks prior to PTCS testing as well as having MSFC resources and personnel available for this type of test. This can often be a cost and schedule impact to PDs and NASA KSC support personnel if these are not made available.

Recommendation: *Provide the direction and funding to bring this type of testing in sync with the KSC PTCS schedules.*

Discussion: The ScS was not designed to be a verification tool that it is now trying to be. This is an incomplete verification test bed for subrack payloads.

Recommendation: *Implement the following nine items (see Suitcase Simulator below) and convert one of the MSFC EXPRESS racks into a tester that can connect into the HOSC for commanding/telemetry/H-S processing so PDs can checkout their payload interfaces prior to going to KSC.*

10. Item Description: Suitcase Simulator

Payload: CPCG

Principal Investigator: Larry Delucas

Item 1: The Suitcase Simulator TReK interface capability needs to be enhanced. Testing (or attempts to test) using the ScS has identified some shortcomings that prevent some significant portions of the payload communicating with its ground systems. The ScS will not pass a health and status packet received from a payload to the TReK interface for processing by the ground systems. This prevents the PD from performing tests that fully exercise the experiment to ground system data flows. A workaround exists that would let the experiment code "fool" the ScS into passing the data on through. This is considered an ill-advised approach because it requires modification of the experiment and ground system software that is ostensibly being tested. Conversations with the ScS Help Desk indicate that a change is being processed to rectify this problem and that the change paper is awaiting approval.

Item 2: The ScS TReK interface is limited to passing data for only one APID for telemetry. Per the EXPRESS IDD interface, a single payload can configure up to six APIDs for telemetry. Further, the ScS otherwise supports the operation of two payloads simultaneously, meaning that if data was being sent over multiple APIDs for telemetry, only data from one of the APIDs from one of the payloads would be available. Payloads that utilize multiple connections (e.g., one for the experiment processor and one for a thermal carrier) cannot adequately exercise the operating configuration of the payload with its ground systems given this constraint of the ScS.

Item 3: Include flight cables that match the flight hardware from a payload perspective as part of the ScS. This shall include the ER front panel data/power connections as well as the ISIS drawer data/power connections.

Item 4: Provide certification of the ScS for connection to flight hardware.

Item 5: Add capability for commanding from a PD's ground system via ScS to a payload.

Item 6: Add a report generation capability. So the PD could utilize this as part of their verification package documentation.

Item 7: Enhance the data display capability to make it easier for users to see a payload H/S as well as telemetry data in something other than HEX values. This would include a real-time data delog capability.

Item 8: Enhance the archival of a payload's H/S and telemetry data so that this might more easily be moved to another platform.

Item 9: Enhance/simplify the user guide.

11. Item Description: Training

Payload: CPCG

Principal Investigator: Larry Delucas

Discussion: The ISS program requires payload simulators be delivered to JSC. This can be very costly in development of high-fidelity equipment that may be utilized for a few hours during crew payload training.

Recommendation*: It's less costly for a project to maintain a qualification unit, as a training device, for internal use and ship it to the training facility when needed.*

Discussion: Payload training is very limited and performed too far in advance of flight. Therefore, hardware must be developed/readied well in advance, which results in added cost to the project. The other risk is payloads could complete hardware development after training and jeopardize experiment success because of crew unfamiliarity.

Recommendation*: Properly integrate training requirements into the development schedule of the experiment payload on a case-by-case basis based on factors such as complexity, whether the experiment has flown before, etc.*

12. Item Description: Operations and Integration Process

Payload: CPCG

Principal Investigator: Larry Delucas

Discussion: NASA Data Review: there is a lag between PD's data submittal and receiving comments. Everyone wants data and now, but when you give it to them, they only check off a box.

Recommendation: *Relook at the template dates and only ask for data in a time frame that NASA can provide the appropriate personnel to review this information.*

Discussion: The label process/requirements keep changing.

Recommendation: *Get the crew office, the human factors people, the decal lab, and some PDs together and define something we can live with and grandfather the current payloads.*

Discussion: At MSFC, there are various configurations of machines, which make up requirements to perform testing or support a simulation or COFR or flight. These machines and their configurations are constantly in a state of flux due to limited funding and resources. The fact that they are in a constant state of flux causes a PD to deal with several problems in testing, simulation support, and COFR. UAB/CBSE and other PDs often are left in a state of catching the misconfigurations and reporting them, then waiting for them to be resolved, before continuing with their work. This, at times, can take extraordinary amounts of time. At times, it can prevent a PD from receiving data during a simulation, and it also prevents them from being able to use applications such as PIMS and MPV during a simulation. Usually, it takes hours to days to get a problem fixed. These problems shouldn't be there to start with, but because they are constantly reconfiguring due to lack of resources these problems appear.

Recommendation: *Properly fund MSFC to configure the systems at MSFC to support the activities for flight and pre-flight. If not, distribute the documented availability of EHS versions for flights and which capabilities they will include. Also, if it is determined that some of these capabilities will not meet the documented EHS versions, then immediately distribute these shortfalls to the PDs.*

Discussion: C&DH telemetry database out of phase with PD's verification needs. The availability of the C&DH telemetry database, which is utilized by the TREK in the verification/checkout process, is out of sync with the needs of PDs.

Recommendation: *PDs would like to request that this process be reevaluated based upon the end-users' needs. As it stands today, this database must be created by hand, which is very labor intensive.*

Discussion: It is difficult to determine where the current SODF and PODF procedures are available, thus, some old ones were used to build simulation/training libraries.

Recommendation: *Institute a clear process for configuration control of experiment procedures onboard and on the ground.*

D.2. Payload Integration Examples

1. Item Description: Electrical Bonding of Payload Structures (Verification Number EL-ER-022). – Requirements from SSP-PVP-ERP, Issue A (3-22-00)

Payload: MEPS

Principal Investigator: Dennis Morrison

Payload Developer: John M. Cassanto

Discussion: The basic bonding requirement makes sense and must and should be performed for any payload or spacecraft. The requirement is to ***verify by test, analysis, and inspection*** (see Figure D-3) that the bonding is as per the requirement. Then a Certificate of Conformance (C of C) and a Verification Inspection Report must be generated and signed off (two separate documents). It would seem prudent to combine these since the C of C is inclusive and states "I hereby certify compliance with the verification requirements as specified in the SSP 52000-PVP-ERP, Issue A". Most payload engineers will not have a problem with this requirement since it is recognized as needed, but only one document (these are one pagers) is really necessary, not two.

In addition, since the payload (MEPS) will be in orbit continuously for more than one increment, we were informed by one of the MSFC contractors that we would have to fill out the paper work (the same C of C) again for the next increment (see Figure D-3). In the first place, my integration person cannot run a bonding test on hardware already onboard ISS. In the second place, if I signed another C of C (which I would not do) stating that the bonding had been tested, analyzed, and inspected, I would be signing up to something that was not true for the date of the second increment. The MSFC contractor thought that it might be possible to write a letter explaining that the hardware had been tested, analyzed, and inspected for the first increment, and would be valid for the next increment. Yes, the payload developer or user could do that, but ***why not change the requirement to take into account that many payloads will fly more than one increment and***

eliminate the user having do duplicate, unnecessary paper work to have someone at the POIC fill out a square.

Recommendation*: This requirement should be modified to eliminate problems associated with a payload staying in orbit for more than one increment. Make the requirement nonincrement-specific.*

2. Item Description: ISS Payload Label Approval Team (IPLAT) Requirements

Payload: MEPS

Principal Investigator: Dennis Morrison

Payload Developer: John M. Cassanto

Discussion (a) Switch Plate Lines boxed – Square or Round Corners: The MEPS I hardware that flew on Shuttle Mission STS-95 was slightly modified for flight on ISS. The main difference being that all ISS payloads must incorporate "rear air" breathing as opposed to Shuttle requirements, which allowed front air breathing. In addition, several other improvements were made to reduce crew time and to make the unit more compact such that the logistics of sample transfer could be made simpler and more efficient. In the process of performing the various tests to accommodate the C of Cs, we ran into a problem with the new nameplate for MEPS. We added additional capability to the front panel, and the requirements states that the switches will be outlined by a visible line to group the switches. On the face of it, this is a realistic rational requirement. The requirement also goes on to state that the enclosure (the corners) for the switched lines can be either squared off or rounded. This payload developer made the decision to square the corners. We were required to submit a drawing of the front plate, which showed of course that we had squared off the corners of the lines grouping the switches. We received a letter back, which said we were "out of spec" and that we had to redo the front plate of the hardware with rounded corners. Since this request was not worthy of an engineer's time, we wrote a letter explaining that the request would not be honored because the requirement clearly states that either option squared or rounded corners was acceptable, and it was a waste of time and money. It did, however, take time and money to document the case that we would not comply. Figure D-4 shows the switch plate that caused time and money to be wasted because of the IPLAT decree. Figure D-5 shows the alleged IPLAT label violation, but also shows the ISS requirement, which is at variance with the IPLAT decree.

Recommendation: *Greatly reduce the authority of IPLAT. Mandate that the IPLAT people who interpret the requirement fully understand the ramifications of their direction, which is sometimes at variance with the requirement. Eliminate the interpretation of the IPLAT to change the requirements. No one cares if the ink lettering around a switch grouping is squared off or has rounded corners. Also, let's use some common sense so we don't waste the time of the PI, the Payload Developer, and the program manager because the program manager and the integration engineer have to send emails and letters to the IPLAT. We do not need a label police. This is clearly a case of time and money being wasted.*

Discussion (b) Arrow pointing to High Voltage Power Supply: The MEPS flight hardware has a high voltage power supply that is controlled by a toggle switch on the front panel. At crew training, it was requested by the crew that we utilize an arrow to identify the LED which indicates power on. Figure D-6 shows the switch with the arrow. IPLAT requested removal of the arrow (see Figure D-6a) because it implied that the switch rotated, even though it is clearly a toggle switch as shown in the photograph.

Recommendation: *Let's get IPLAT and the crew on the same page so that needless emails and letters are not needed to resolve non-issues. The IPLAT request is understandable; however, the crew will operate the payload, and if the crew and the PI/PD are comfortable with the switch functions, there is joy.*

Discussion (c) Add arrow on standard videotape for direction of insertion: The MEPS flight hardware utilizes a standard COTS video recorder that has been ruggedized to record the formation of microcapsules. It therefore utilizes standard videocassette tapes that need to be changed out periodically. IPLAT requested that the videotape cassettes be modified with an arrow for direction of insertion as shown in Figure D-7. Both the PI and the PD believe that the crew are intelligent and have sufficient background and training to insert the standard tape cassette properly without having to add an arrow for direction of insertion.

Recommendation: *We do not need to overcomplicate simple procedures. Video recorders are standard, and there is no need to modify COTS cassette tapes with insertion instructions for the crew.*

Discussion (d) Go, No-Go vs. Ready/Not Ready LEDs: The MEPS flight hardware contains two LEDs (see Figure D-8), which indicate that the experiment can be conducted or cannot be conducted and state Go, No-Go. IPLAT recommended that this be changed to Ready/Not Ready (see Figure D-8a). The crew did not object to the Go, No-Go nomenclature, and it would be costly to change the silk-screened controller panel. In addition, the wording Ready/Not Ready would not fit on the panel. Accordingly, we are flying with the Go, No-Go nomenclature. Again, wasted time and money.

Recommendation: *We need to rely more on the crew and their inputs. If at crew training, the crew is happy with the labeling, and the PI/PD is confident that the crew understands the hardware and is comfortable with it, it is not clear why IPLAT is needed for this specific example.*

3. Item Description: Payload Color Front Plate Requirement

Payload: MEPS

Principal Investigator: Dennis Morrison

Payload Developer: John M. Cassanto

"Payloads shall select interior colors in accordance with the requirement of SSP 5000-IDD-ERP, Table 12-1. (12.5.1)".

Discussion: The MEPS Shuttle payload with modifications was going through the payload integration cycle to be reflown on ISS. The hardware is basically the same with the exception of the addition of rear air breathing (ISS requirement) and minor changes that reduced crew time. The PI/PD was told that the color of the unit, blue, (on the front end and faceplate) was wrong and had to be off-white. Please see Figure D-9 for the ISS color requirement (section 12.5.1 of SSP 52000-IDD-ERP Issue B dated 12/13/00). After many discussions and emails/letters the PD decided that the prudent thing to do was to ignore the requirement and document the decision with a letter. The payload will fly as the same color it was on Shuttle. Again, time and money was wasted. *One could make an argument for a standard color for new ISS payloads being developed from the ground up, but it is not obvious why there has to be a spec on the payload color. There is no color spec on Shuttle payloads.*

Recommendation: *Eliminate this requirement for existing Shuttle payloads that will fly on ISS. Let's get some common sense back into space experiments. No one should care what color the payload or the front panel is so long as it passes all of the required tests (outgassing, EMI, vibration, acoustics etc), and the massive amount of integration paper work is provided, and has approval from the JSC safety board to fly.*

4. Item Description: Microgravity Testing of the ZCG-FU hardware

Payload: ZCG-FU

Principal Investigator: Al Sacco

Discussion: An exorbitant amount of time and money was put into accomplishing these tests that could have been saved for others activities. The tests cost in the neighborhood of $20,000 to perform not including all the ancillary costs to support it by NASA and payload personnel.

Recommendation: *A simple evaluation of the hardware would have shown that its microgravity impact was insignificant compared to the requirement.*

5. Item Description: Acoustics Verification

Payload: CPCG

Principal Investigator: Larry Delucas

Discussion: UAB engineers went to great lengths to make a set of flight incubators as quiet as possible and then we performed a preliminary test in our acoustics chamber at UAB. An engineer observing the test noted that we were exceeding the ISS allowable acoustics levels. We then informed him that we had not yet turned the unit on. It turns out that the air passing through our acoustic chamber's baffels on the top of our anechoic chamber were making more noise than the ISS requirement allows. When we finally turned our incubator on, it too, was exceeding the ISS requirements. We then used a great deal of time and money designing a muffler to cover the air vent (this is the only item that produces any sound from the unit).

For acoustic testing, it is required that the background noise levels be at least 20dB below the readings on the unit. So if the hardware produces a 40db noise level at 500Hz, the ambient noise level of the test facility should be 20db or below at 500 Hz. Thus, for ISS ER requirements, we must have an anechoic chamber that does not produce background noise levels more than 12 to 18 db for several frequencies. The anechoic chambers we have historically used (UAB's test chambers at the Spain Hearing and Speech Clinic) are unable meet this specification, so we tested our experiments at a MSFC Facility.

During an ISS training session we demonstrated the unit to several ISS program representatives and crew representative. Their first comment was to turn the unit on so they could get a perspective of the noise issue. As it turned out, the unit was already up and running. This demonstration was performed in a crew classroom (conference room) with only UAB and ISS personnel present. It was absolutely impossible to make the unit any more quiet, so eventually we were forced to get a waiver, after many months and a lot of money were expended to meet a ridiculous requirement.

In summary the program is mandating unrealistic requirements on small payloads built for Shuttle when the real noise producers are the vehicle systems and subsystems. We have received numerous feedback comments from Shuttle crews that have stated "it is impossible to hear these units against the background noise of the vehicle". So why are we spending big bucks imposing unnecessary/unrealistic requirements on the experiments.

Recommendation*: The acoustic limits are too low, probably unrealistic. There seems to be more background noise on ISS than payload related noise. Modify payload acoustics limits (raise them) using ex-payload specialists as a sanity check to obtain a realistic value rather than an artificial number. If astronauts would wear earplugs (with microphones in them) or headphones, we could substantially relax the acoustics requirement and save a tremendous amount of money and time for every payload being developed for the ISS. An astronaut wearing an earplug or headphone for the 3-month increment is no different than wearing glasses for the same time period!*

6. Item Description: Ground and Flight Safety Data Packages

Payload: ZCG-FU

Principal Investigator: Al Sacco

Discussion: Ground and flight safety data packages should be combined and reviewed together. Much of the information is the same in both packages. This way we could go through one cycle of review and response.

Recommendation*: Change the format to combine the inputs utilizing typical PIs/PDs that have been through the system in conjunction with the ground and flight safety data package people.*

7. Item Description: Toggle Switch Angular Throw Requirement

Payload: ZCG-FU

Principal Investigator: Al Sacco

Section 12.6 (Verification Number HF-ER-020) of SSP 52000-PV-ERP, Issue A, dated 3/22/00 toggle switch displacement requirements.

Discussion: The toggle switch exception PIRN to satisfy the HF-ER-020 requirement (see Figure D-10) took 6 months to process to satisfy the fact that the ZCG circuit breaker displacement is 30 degrees versus the 22-degree requirement. This requirement should have been met by crew approval in training on our hardware.

Recommendation*: Eliminate the formal requirement, modify it to be a guideline, and use crew approval in training on the hardware to meet the guideline. Put common sense consistent with safety requirements back into conducting space flight experiments.*

8. Item Description: Express Rack Verification

Payload: ZCG-FU

Principal Investigator: Al Sacco

Discussion: Express integration teams at times take too long to evaluate the submitted verification data.
Recommendation: Speed up the process on the MSFC side.

9. Item Description: Drawing Requirements/Comments

Payload: MEPS

Principal Investigator: Dennis Morrison

Payload Developer: John M. Cassanto

9(a) A drawing will be generated for every item on board ISS.

Discussion: (1) The MEPS payload incorporates a commercial ruggedized video recorder that uses a standard videotape. We were required to provide an engineering drawing of a standard videotape cassette that can be purchased from K-Mart or Target that is utilized by most of the inhabitants of the civilized world. It should be noted that these tapes are included in a flight pouch, which also has a drawing. Clearly, the flight pouch drawing with dimensions that the tapes go into is needed, but it is a waste of time and money to draw a tape cassette. The drawing has to be generated, by a draftsman, then reviewed by an engineer, then checked, and finally signed off by the program manager. Again, time and money has been wasted. Figure D-11 shows the signed off drawing of the videotape cassette. If we are to document everything on ISS, there is an easier way. ***Why not take a digital photo? It serves the same purpose and saves time and money.***

(2) The MEPS payload incorporates a standard PCMCIA card that is standard on all computers today. Several cards also fly in a stowage pouch. Figure D-12 shows the signed off drawing for the PCMCIA card. Same argument as above.

Recommendation*: Revisit this requirement and eliminate those items that don't make sense and waste time and money.*

9(b) Several groups ask for drawings.

All investigators and developers on the POCAAS team.

Most of the time the drawings are in PDL, but the requesters do not have access or do not wish to take the time to retrieve these. We have to supply drawings to IPLAT, rack integrators, KSC PTCS integration team, and stowage to name a few.

- Data that was input and placed into a final format is not being carried over and used by the next increment/flight team. These include KSC TAPs, SODF procedures. This is getting better and the problems partially are because these processes start earlier that the previous flight data items being baselined. It would be better to have the process start later and have correct information/data items the first time through.

- Procedures:
  - Too many NASA people touching drawings
  - No clear actively used process (not consistent from increment to increment) Process in interpreted differently by different personnel
  - Procedure people look at wrong procedures because of the unclear process
  - PDs do not know where to input data. (OPMS-Which wing or is it PIMS)
  - The procedure input process starts too early and the training procedures are never the correct latest PD procedures. If a payload was previously flown, then the procedures should be in PIMS, but a PD cannot OCR changes to these until around launch-3 months, which is too late for the training.
  - Changes for some reason do not fully get implemented into SODF and PODF procedures and PD has to continuously check these for correctness.

Recommendation: *Review with PIs/PDs to eliminate the onerous drawing requirements.*

D-3. Miscellaneous

Management Issues

Payload: CPCG

Principal Investigator: Larry DeLucas

a) Item Description: Research and experiment success not emphasized or properly prioritized within the ISS program.

Recommendation*: Mandate a new program directive to support science or give science an advocate within the program at the highest levels.*

b) Item Description: The ISS payload program has far too many different organizations each with its own support staff. It is all but impossible for a small PI/PD team to effectively interface with an organization of this size.

Recommendation*: Ideally, the Research Program Office should be solely responsible as the interface between the PD and ISS, or the RPO should delegate all technical authority to the PD for working directly with ISS, EXPRESS, etc.*

c) Item Description: Invoking the Program Requirements on Payloads (PRP) document is too stringent, and not cost effective.

Recommendation: *The PRP is more suited as a guide that a NASA manager in the appropriate RPO could use to manage risk in selecting requirements consistent with the complexity of the payload and the experience of the PD.*

2. Development Issues

Payload: CPCG

Principal Investigator: Larry Delucas

a) Item Description: Research and experiment success not emphasized or properly prioritized within the ISS program. Level of effort required by PD teams to review and comment to PIRNs, CRs, facility documentation, unbaselined documents, coordination copies, draft issues, initial release, and white papers is excessive. Yet the ISS and/or facility program have mandated no technical support to payload developers in experiment design/development. ***The mass of paper created and required by the ISS program is staggering.***

Recommendation: *Minimize requirement changes. Go through an intense requirements review process to revise only what really needs to be changed. Stop the new CR/PIRNs daily changes out every other day business. Deal with individual situations as they occur, keep a running list and then update the documents every year. Only process real value-added requirements.*

a) Item Description: As stated in the management section above, documents like the newly released ISS Program Requirements for Payloads (PRP) document threaten the ability to cost-effectively develop new hardware. As it is presently written, the PRP is a serious cost impact to all existing hardware and will seriously impact the way costing of future hardware is accomplished. In some cases, it may be more cost effective to scrap a system in development as opposed to upgrading to the new requirements. General examples of new requirements imposed by the PRP include a menagerie of new planning documents, a stringent Mil-Std approach to parts selection, complex and costly reliability analyses, etc., that may limit ISS payload development to major aerospace organizations. We believe that even if the PD did complete all of the necessary documentation required by the PRP, NASA is not adequately staffed to review it. As a general rule, the CBSE has found that the impacts from this document approximately double the cost of payload development. The PRP effectively removes the ability of a project to make its own cost versus performance trades. CBSE has flown 37 successful missions without these "reliability at any expense" types of requirements. Safety concerns aside, can we afford "a highest reliability at any expense approach" in this budget environment? Although "better, faster, cheaper" may become a politically incorrect phrase to use after recent troubles with the Mars probes, swinging the pendulum back to the other extreme is not felt to be in the best interest of the program, either. These facts were brought to the attention of PRP authors on several occasions, but the response was the PRP has been baselined and the PD must comply.

Recommendation: *The PRP is more suited as a guide that a NASA manager in the appropriate RPO could use to manage risk in selecting requirements consistent with the complexity of the payload and the experience of the PD.*

b) There is a lack of clear integration process for payload developers. The amount of ISS documentation is excessive and is spread out over a vast number of different organizations. Several years ago, an ISS Engineering Study Team chaired by the current ISS payload program manager identified this issue as one of their primary findings in the final report. To date, a detailed user handbook still does not exist.

Recommendation: *Develop a meaningful user handbook that can be used by the PD as a guide through the process.*

D.4. Documentation

1. Item Description: Experiment Requirements Input – PDL

Payload: CPCG

Principal Investigator: Larry Delucas

The ISS program is utilizing electronic databases for a wide range of data input. The existing PDL system is not as straightforward as expected. There are concerns that this system has become so large and complex that it is a hindrance to streamlined payload integration. In our experience, the PDL has become increasingly costly to the program and is not user-friendly. It should be observed that this system is also not linked with other systems in the ISS Program that require the exact same data from the PD. Also, the method of configuration management of the data content in the PDL is unclear. This issue can result in inconsistencies in the data content and errors in its use. There should be a method for payload developers to work off-line within their organization to complete this information more accurately on an organizational team level. The system is designed for one person on one computer inputting data. Ultimately, the PDs lack configuration control of this information once it promoted to the ISS organizational level. In our opinion, the PDL system, although a good concept for reduction of paper and centralization of data, is more tailored to the ISS integration program process than a useful tool for PDs.

Recommendation: *The ideal solution would be a data library function that can be maintained on the PD's machine with inputs/updates being periodically uploaded to the PDL or database system when necessary. Also, most of these systems (PDL, URC, etc.) are tailored to the ISS program requirements and, at present, not optimized for the PD or any ISS user. Finally, in addition to the input process being labor intensive, the PDL does not allow for simple transfer of information from one payload or flight to the next (i.e. re-flights, similar experiment systems, etc.). Presently, the only method for reusing data is to have the PDL maintenance organization to create a duplicate library for an existing payload and then modify/remove all changed/nonapplicable data. For our SSP experiments, our documentation (PIP, annexes) remains the same and has required little if any changes from flight to flight. The only changes made to our experiment series documents over the past several years, was when we made hardware modifications that impacted the performance characteristics of the hardware.*

2. Item Description: PDs are required to resubmit PIRNs for every flight (even while you are on-orbit)

Payload: CPCG

Principal Investigator: Larry Delucas

Recommendation: The PD submits a PIRN with the SYSTEM/ELEMENT AFFECTED AND STAGE EFFECTIVITY filled in to cover the launch through the return flight or through the planned re-flights.

3. Item Description: PDs are required to resubmit COFR for every flight, even if they are just staying on-orbit.

Payload: CPCG

Principal Investigator: Larry Delucas

***Recommendation**: The PD submits one COFR to cover the payload launch, on-orbit and return flights.*

4. Item Description: PDs are required to input and move data.

Payload: CPCG

Principal Investigator: Larry Delucas

Discussion: The PDs are required to input data into flights and increments and if the flight moves, then the PDs have to move the data (or yes have it copied and verify the copy worked, some data cannot be copied in PDL such as diagrams, drawings figures). This is inefficient and is subject to human error.

***Recommendation:** Have the PD input data for a payload rather than for a particular flight/increment.*

5. Item Description: Moving Hardware

Payload: CPCG

Principal Investigator: Larry Delucas

Discussion: Some of the PD's hardware is moved from one flight to the other. The PD must then go delete this data from one place and add it to another.

***Recommendation:** If the program pre-positions hardware from one flight to the other, they should handle having these items moved within PDL, while keeping the PD in the loop.*

6. Item Description: Moving Payload Item

Payload: CPCG

Principal Investigator: Larry Delucas

Discussion: Each time a payload or payload item is moved, a PD must have the PDL team move the appropriate data.

***Recommendation:** Add a capability in PDL enabling the PDs to copy their own data between flights/increments and their associated payload accounts.*

7. Item Description: PDL not keeping up with baseline documentation

Payload: CPCG

Principal Investigator: Larry Delucas

Discussion: PDL not keeping up with baseline documentation as well as station decisions. Such as the PDL does not reflect the EXPRESS Rack IDD (SSP 52000-IDD-ERP, Issue B); and thus, we have to submit paper ICDs and PVPs for now and later place into PDL**.** The PDL group has been provided with comments per the POIWG request several times, but appears that no funding is available to even evaluate the PD's comments.

Recommendation: *Provide direction to PDL to revise its system as ISS documentation is revised. Update the PDL blank-book to reflect current design.*

8. Item Description: Payload information not included.

Payload: CPCG

Principal Investigator: Larry Delucas

Discussion: In our experience, payload information was not included for the return flight increment. Thus, when an early transition to the next increment was performed, the system lost the ability for processing the current on-orbit payloads health/status, telemetry, and commands.

Recommendation*: Include payloads in the database for their return flight or next increment for early transition purposes.*

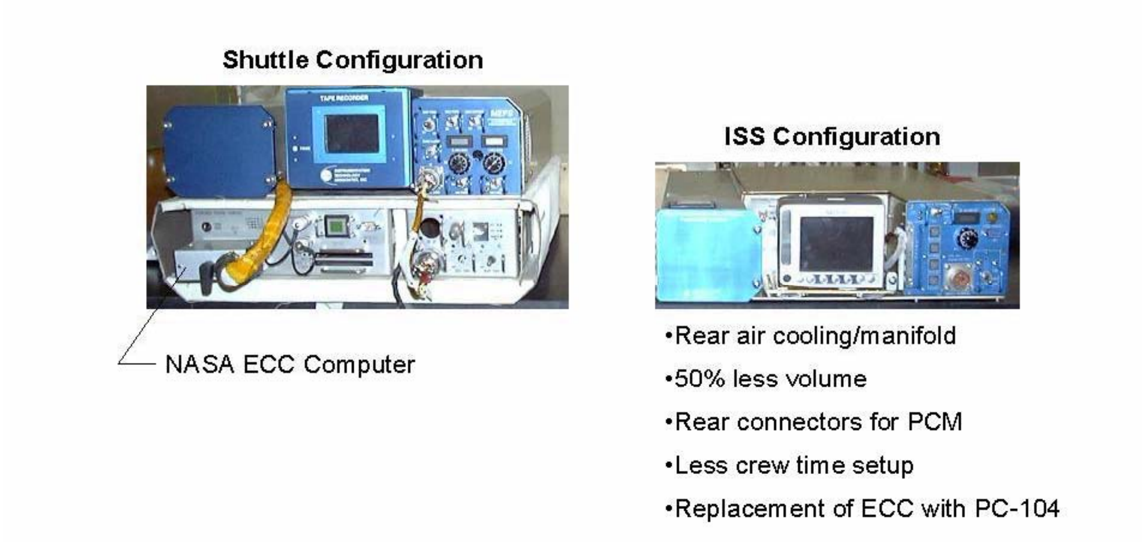


Figure D-1. ***Comparison of Microencapsulation Hardware for Shuttle with Repackaged, Reengineered Hardware for ISS***

Experiment Operations Checklist
MEPS
STS-95 Flight Supplement
Final: September 16, 1998

Figure 2

MDC 98W5686

STS-95

CHAMBER CHANGEOUT

AS04 1. ✓STATUS pb display blank

2. cb ECC SW1 - ON
✓STATUS pb displays:
'READY'
cb EXP SW2 - ON

3. H/V PWR S5 sw - ON

4. E ADJ (KV) sel - 0 (max ccw)
I ADJ (MA) sel - 0 (max ccw)
✓E ADJ (KV) LCD displays < '0.01'
✓I ADJ (MA) LCD displays < '0.6'

5. cb EXP PWR S1 - OFF

AS04 6. CAM/LAMP S4 sw - OFF (center position)
REC PWR S2 sw - OFF (center position)
✓REC STATUS S3 sw - STBY
H/V PWR S5 sw - OFF (center position)

7. cb ECC SW1 - OFF
cb EXP SW2 - OFF

8. ✓TAPE RECORDER video display for broken glass fragments
• If broken glass fragments found, ✓ MCC

ISS

MEPS CHAMBER CHANGEOUT
MGUEEXPRSMEPSN003

Start_IMS

STATION PARTS:
PCM IN ZIPLOC BAG
DATA CAPTURE KIT
PCMCIA CARD

1. PCM CHANGEOUT
1.1 Open EXPRESS LOCKER door.

1.2 Perform {MEPS DEACTIVATION}, all, then

1.3 Inspect VIDEO MONITOR/RECORDER for broken glass fragments.

****
If broken glass is found,
√POIC
****

Figure D-2. ISS PCM Change Out Procedure

Figure 3

SSP 52000-PVP-ERP, Issue A
3/22/00

VERIFICATION REQUIREMENT DEFINITION SHEET

Verification Number	Requirement Title	Verification Method
EL-ER-022	Electrical Bonding of Payload Structures	A and T and I
		Hazard Report Number

Electrical Verification Requirement:

1. The primary payload bond path is through the EXPRESS Rack-to-payload power connector interface. The bond path shall be accomplished by a single 12-AWG wire in the primary power connector capable of carrying a current of 24 A.

   Bonds shall meet the appropriate bond class requirements of paragraph 7.5.1, "Electrical Bonding," and shall have less than or equal to 2.5 milliohms at each junction of the fault bond interface.

   Payloads that will be powered in the Shuttle middeck shall meet the middeck requirement of less than or equal to 0.25 milliohms at each junction of the fault current bond interface. (7.5.1.2.1.1)

2. If necessary, the payload-to-EXPRESS Rack bond strap shall be payload provided and shall be designed to be connected to the EXPRESS Rack structure and payload's ground attachment provisions. This bond shall meet the requirement of paragraph 7.5.1, "Electrical Bonding," and shall have less than or equal to 2.5 milliohms at each junction of the fault current bond interface. (7.5.1.2.1.2)

3. The payload-to-EXPRESS Rack mated surface bond (defined as the payload, adapter plate, or MDL surface that attaches to the EXPRESS Rack back plate) is a removable bond and shall be nickel or nickel plated per SSP 30245 using methods in MIL-C-26074 or D683-29033-1. The maximum resistance between the mated surfaces of the bond connection (connector to mounting base, mounting base to EXPRESS Rack, or when applicable, mounting base to payload) shall be less than or equal to 2.5 milliohms (Class R) at each junction of the fault current bond interface. (7.5.1.2.1.3)

   All the aluminum surfaces used for permanent bonding in the payload shall be originally cleaned to bare metal, then chemically filmed per MIL-C-5541, Class 3 (gold alodine 1200LN9368 or equivalent) or nickel plated using methods in MIL-C-26074.

Description of Verification Method:

1. Verify by inspection that the payload power connector has a 12-AWG wire, capable of carrying a fault current of 24 A, from the ground contact of the connector to the payload chassis.

   Verify by test that the primary connector bond junctions have less than or equal to 2.5 milliohms.

   For payloads that will be powered in the middeck, verify by test that the primary connector bond junctions have less that or equal to 0.25 milliohms at each junction of the fault bond interface.

2. Verify by analysis that the payload-to-EXPRESS Rack bond strap is provided by the payload and is connected between the EXPRESS Rack structure and the payload ground attachment provisions.

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Figure D-3. Basic Bonding Requirement (1 of 2)

Figure 3, continued

SSP 52000-PVP-ERP, Issue A
3/22/00

VERIFICATION REQUIREMENT DEFINITION SHEET (CONTINUED)

Verification Number	Requirement Title	Verification Method
EL-ER-022	Electrical Bonding of Payload Structures	A and T and I
		Hazard Report Number

Description of Verification Method: (Continued)

Verify by test that the bond strap attachment points meet the requirements for a Class R bond and have less than or equal to 2.5 milliohms at each junction.

3. Verify by analysis that the payload-to-EXPRESS Rack mated surface bond (defined as the payload, adapter plate, or MDL surface that attaches to the EXPRESS Rack backplate) is nickel or nickel-plated per SSP 30245 using methods in MIL-C-26074 or D683-29033-1.

Verify by analysis that all aluminum surfaces used for permanent bonding in the payload are originally cleaned to bare metal, then chemically filmed per MIL-C-5541, Class 3 (gold alodine 1200LN9368 or equivalent) or nickel-plated using methods in MIL-C-26074, Class 4, Grade A.

Verify by test that the maximum resistance between the mated surfaces of the bond connection (connector to mounting base, mounting base to EXPRESS Rack, or when applicable, mounting base to payload) is less than or equal to 2.5 milliohms at each junction of the fault current bond interface.

Required Verification Data:	*Data Submittal Dates:*
Certificate of Compliance (COC) with the requirement.	L-6 mo

Description of Reverification Requirements:

1. On-orbit subrack PL changeout: Same as the "Required Verification Data" identified above.
2. Payloads remaining on-orbit past the original period of certification of the safety features or inhibits must perform a re-verification of the activities as identified in the "Description of the Verification Method" identified above.

This is the reverification requirement for safety features as per NSTS 18798B, MA2-98-135. It covers not only items that are limited operating life items (i.e., batteries, seals, etc.) but also items such as micro-switches, PRVs, etc., that perform the safety control function for a payload hazard.

Required Reverification Data:	*Data Submittal Dates:*
1. COC 2. Same as "Required Verification Data" identified above.	L-6 mo

Applicable Documents and Notes:

D683-29033-1
MIL-C-5541
MIL-C-26074
MIL-STD-1686
SSP 30245
SSP 52000-IDD-ERP: par 7.5.1.2.1.1, 7.5.1.2.1.2, 7.5.1.2.1.3

Figure D-3. Basic Bonding Requirement (2 of 2)

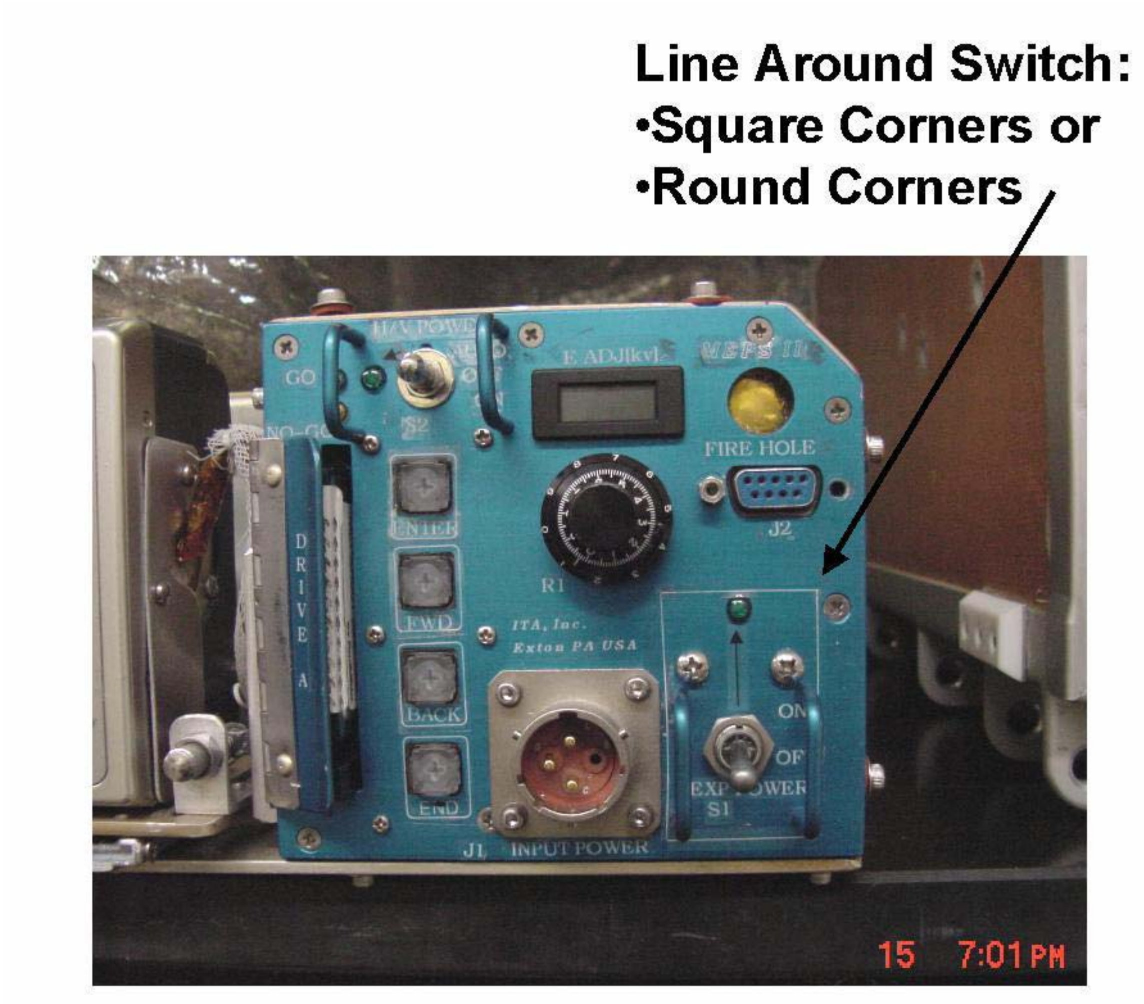


Figure D-4. ISS Hardware—MEPS Faceplate
Example of Unrealistic Requirement That Should Be Changed

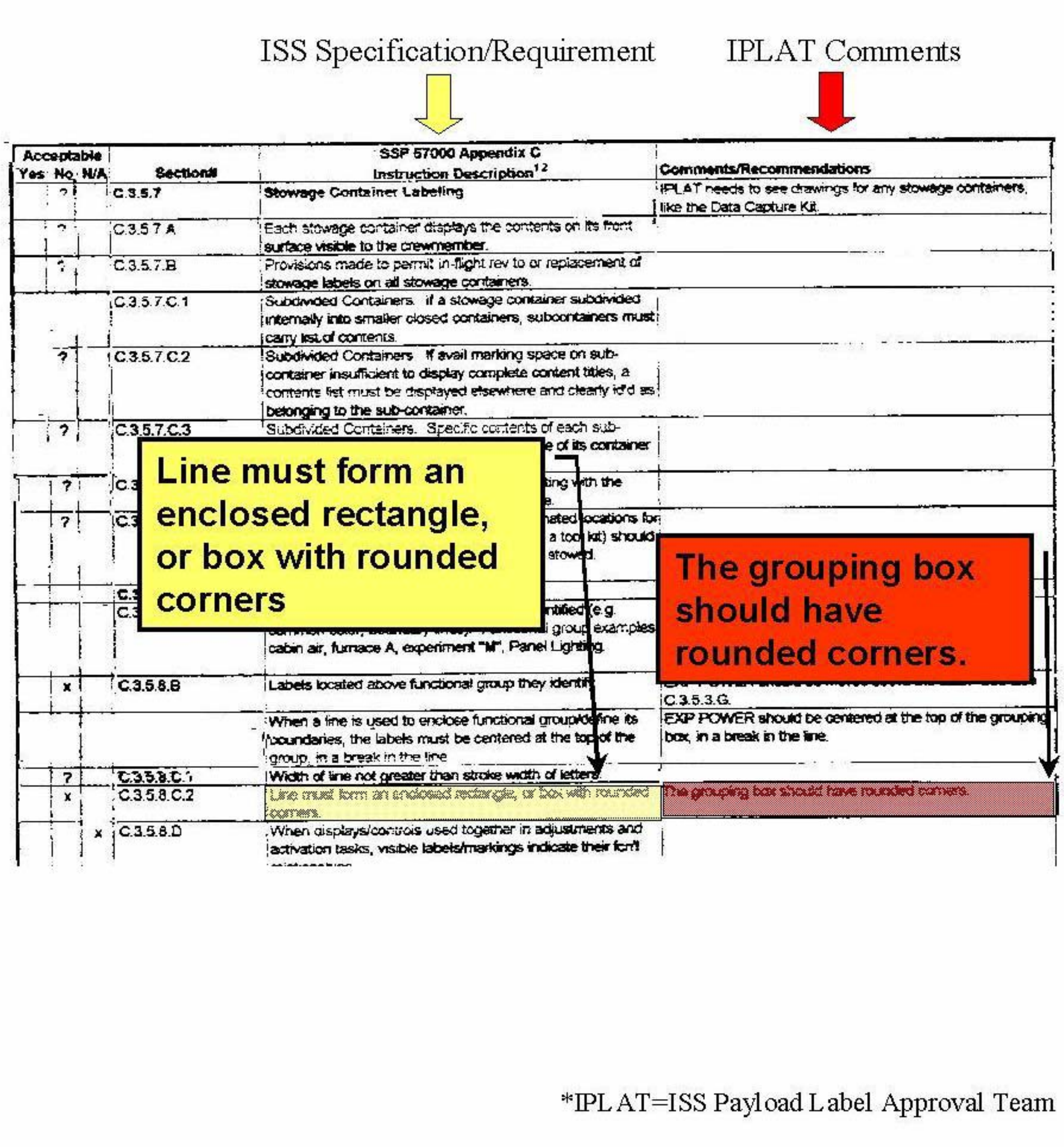
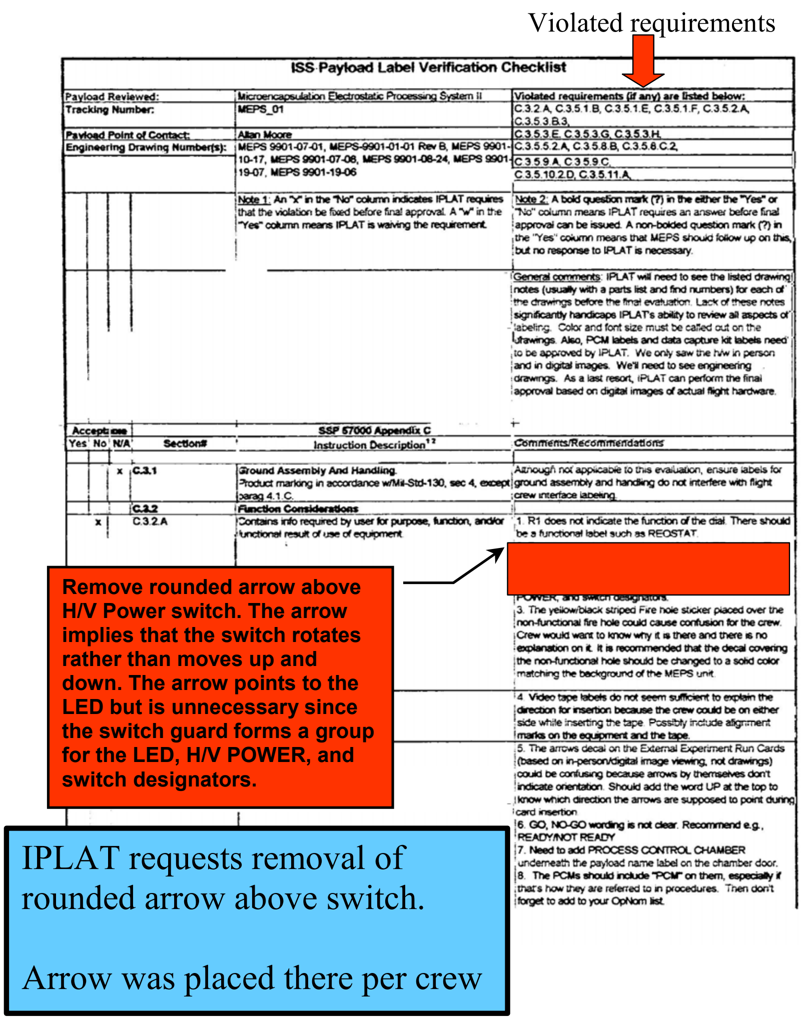


*Figure D-5. Example of ISS MEPS Payload Label Violation from IPLAT**

Figure D-6. Switch With Arrow



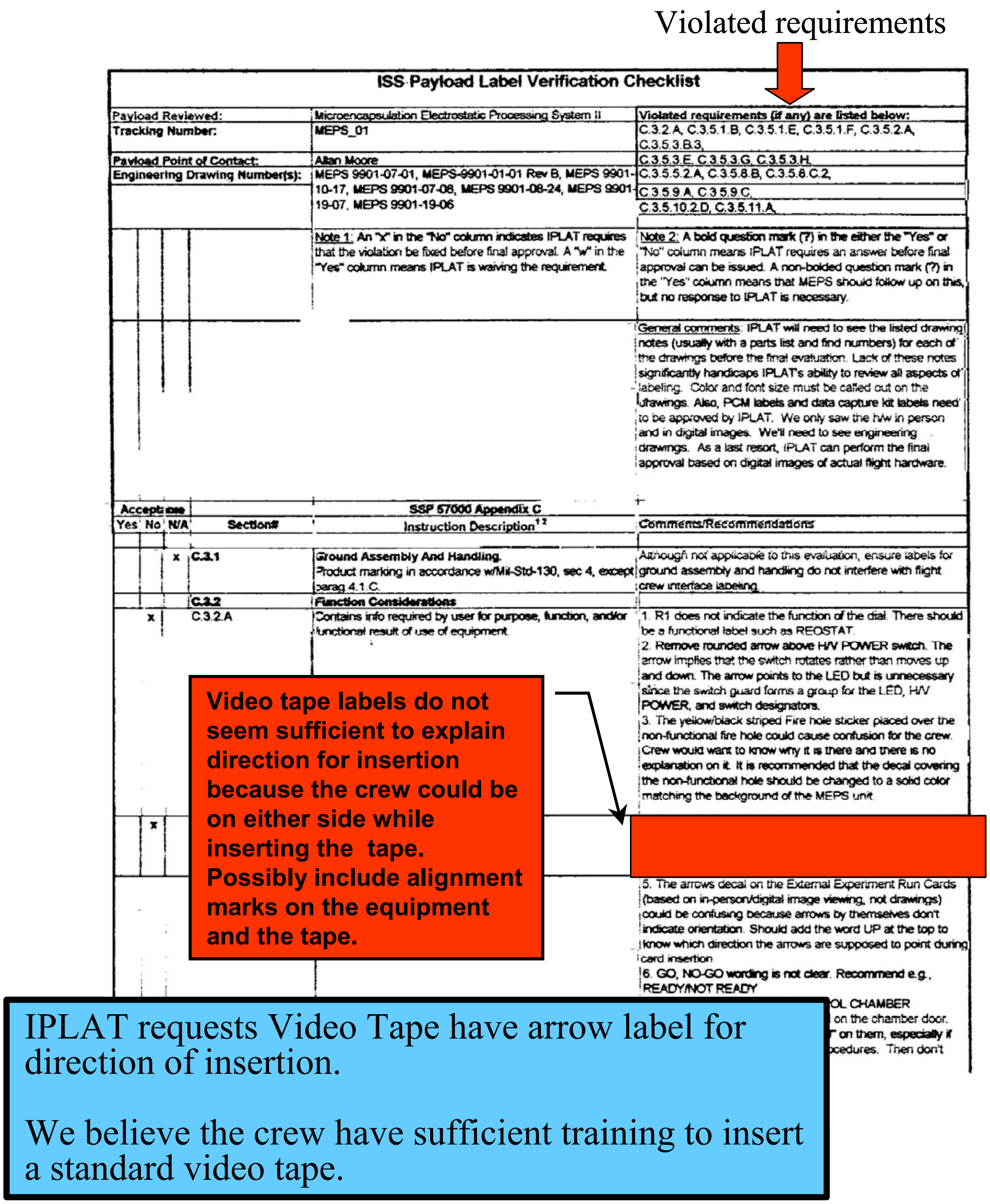
ISS Payload Label Verification Checklist

Payload Reviewed:	Microencapsulation Electrostatic Processing System II	Violated requirements (if any) are listed below:
Tracking Number:	MEPS_01	C.3.2.A, C.3.5.1.B, C.3.5.1.E, C.3.5.1.F, C.3.5.2.A, C.3.5.3.B.3,
Payload Point of Contact:	Allan Moore	C.3.5.3.E, C.3.5.3.G, C.3.5.3.H,
Engineering Drawing Number(s):	MEPS 9901-07-01, MEPS-9901-01-01 Rev B, MEPS 9901-10-17, MEPS 9901-07-08, MEPS 9901-08-24, MEPS 9901-19-07, MEPS 9901-19-06	C.3.5.5.2.A, C.3.5.8.B, C.3.5.8.C.2, C.3.5.9.A, C.3.5.9.C, C.3.5.10.2.D, C.3.5.11.A,
	Note 1: An "x" in the "No" column indicates IPLAT requires that the violation be fixed before final approval. A "w" in the "Yes" column means IPLAT is waiving the requirement.	Note 2: A bold question mark (?) in the either the "Yes" or "No" column means IPLAT requires an answer before final approval can be issued. A non-bolded question mark (?) in the "Yes" column means that MEPS should follow up on this, but no response to IPLAT is necessary.
		General comments: IPLAT will need to see the listed drawing notes (usually with a parts list and find numbers) for each of the drawings before the final evaluation. Lack of these notes significantly handicaps IPLAT's ability to review all aspects of labeling. Color and font size must be called out on the drawings. Also, PCM labels and data capture kit labels need to be approved by IPLAT. We only saw the h/w in person and in digital images. We'll need to see engineering drawings. As a last resort, IPLAT can perform the final approval based on digital images of actual flight hardware.

Acceptance Yes	No	N/A	Section#	SSP 57000 Appendix C Instruction Description[1 2]	Comments/Recommendations
		x	C.3.1	Ground Assembly And Handling. Product marking in accordance w/Mil-Std-130, sec 4, except parag 4.1.C.	Although not applicable to this evaluation, ensure labels for ground assembly and handling do not interfere with flight crew interface labeling.
			C.3.2	Function Considerations	
	x		C.3.2.A	Contains info required by user for purpose, function, and/or functional result of use of equipment.	1. R1 does not indicate the function of the dial. There should be a functional label such as REOSTAT. POWER, and switch designators. 3. The yellow/black striped Fire hole sticker placed over the non-functional fire hole could cause confusion for the crew. Crew would want to know why it is there and there is no explanation on it. It is recommended that the decal covering the non-functional hole should be changed to a solid color matching the background of the MEPS unit. 4. Video tape labels do not seem sufficient to explain the direction for insertion because the crew could be on either side while inserting the tape. Possibly include alignment marks on the equipment and the tape. 5. The arrows decal on the External Experiment Run Cards (based on in-person/digital image viewing, not drawings) could be confusing because arrows by themselves don't indicate orientation. Should add the word UP at the top to know which direction the arrows are supposed to point during card insertion. 6. GO, NO-GO wording is not clear. Recommend e.g., READY/NOT READY 7. Need to add PROCESS CONTROL CHAMBER underneath the payload name label on the chamber door. 8. The PCMs should include "PCM" on them, especially if that's how they are referred to in procedures. Then don't forget to add to your OpNom list.

*IPLAT = ISS Payload Label Approval

*Figure D-6a. Example of ISS MEPS Payload Label Violations from IPLAT**



ISS Payload Label Verification Checklist

Payload Reviewed:	Microencapsulation Electrostatic Processing System II	Violated requirements (if any) are listed below:	
Tracking Number:	MEPS_01	C.3.2.A, C.3.5.1.B, C.3.5.1.E, C.3.5.1.F, C.3.5.2.A, C.3.5.3.B.3,	
Payload Point of Contact:	Allan Moore	C.3.5.3.E, C.3.5.3.G, C.3.5.3.H,	
Engineering Drawing Number(s):	MEPS 9901-07-01, MEPS-9901-01-01 Rev B, MEPS 9901-10-17, MEPS 9901-07-08, MEPS 9901-08-24, MEPS 9901-19-07, MEPS 9901-19-06	C.3.5.5.2.A, C.3.5.8.B, C.3.5.8.C.2, C.3.5.9.A, C.3.5.9.C, C.3.5.10.2.D, C.3.5.11.A,	

Note 1: An "X" in the "No" column indicates IPLAT requires that the violation be fixed before final approval. A "w" in the "Yes" column means IPLAT is waiving the requirement.

Note 2: A bold question mark (?) in the either the "Yes" or "No" column means IPLAT requires an answer before final approval can be issued. A non-bolded question mark (?) in the "Yes" column means that MEPS should follow up on this, but no response to IPLAT is necessary.

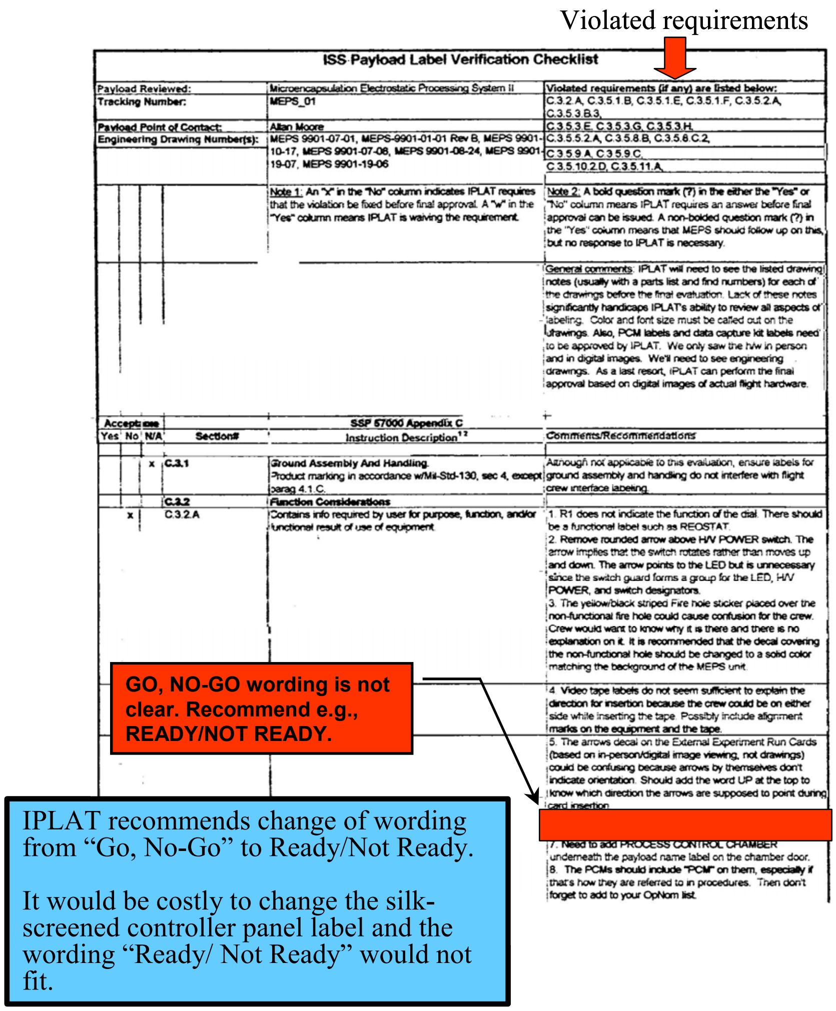
General comments: IPLAT will need to see the listed drawing notes (usually with a parts list and find numbers) for each of the drawings before the final evaluation. Lack of these notes significantly handicaps IPLAT's ability to review all aspects of labeling. Color and font size must be called out on the drawings. Also, PCM labels and data capture kit labels need to be approved by IPLAT. We only saw the h/w in person and in digital images. We'll need to see engineering drawings. As a last resort, IPLAT can perform the final approval based on digital images of actual flight hardware.

Acceptance Yes	No	N/A	Section#	SSP 57000 Appendix C Instruction Description[1 2]	Comments/Recommendations
		x	C.3.1	**Ground Assembly And Handling.** Product marking in accordance w/Mil-Std-130, sec 4, except parag 4.1.C.	Although not applicable to this evaluation, ensure labels for ground assembly and handling do not interfere with flight crew interface labeling.
			C.3.2	**Function Considerations**	
	x		C.3.2.A	Contains info required by user for purpose, function, and/or functional result of use of equipment	1. R1 does not indicate the function of the dial. There should be a functional label such as REOSTAT. 2. Remove rounded arrow above H/V POWER switch. The arrow implies that the switch rotates rather than moves up and down. The arrow points to the LED but is unnecessary since the switch guard forms a group for the LED, H/V POWER, and switch designators. 3. The yellow/black striped Fire hole sticker placed over the non-functional fire hole could cause confusion for the crew. Crew would want to know why it is there and there is no explanation on it. It is recommended that the decal covering the non-functional hole should be changed to a solid color matching the background of the MEPS unit.
	x				
					5. The arrows decal on the External Experiment Run Cards (based on in-person/digital image viewing, not drawings) could be confusing because arrows by themselves don't indicate orientation. Should add the word UP at the top to know which direction the arrows are supposed to point during card insertion. 6. GO, NO-GO wording is not clear. Recommend e.g., READY/NOT READY ... OL CHAMBER ... on the chamber door. ..." on them, especially if ...ocedures. Then don't

*IPLAT = ISS Payload Label Approval Team

Figure D-7. Example of ISS MEPS Payload Label Violations from IPLAT*: Video Tape

Figure D-8. ISS Hardware - MEPS Faceplate GO/NO-GO Wording on LEDs



ISS Payload Label Verification Checklist

Payload Reviewed:	Microencapsulation Electrostatic Processing System II	Violated requirements (if any) are listed below:
Tracking Number:	MEPS_01	C.3.2.A, C.3.5.1.B, C.3.5.1.E, C.3.5.1.F, C.3.5.2.A, C.3.5.3.B.3,
Payload Point of Contact:	Allan Moore	C.3.5.3.E, C.3.5.3.G, C.3.5.3.H,
Engineering Drawing Number(s):	MEPS 9901-07-01, MEPS-9901-01-01 Rev B, MEPS 9901-10-17, MEPS 9901-07-08, MEPS 9901-08-24, MEPS 9901-19-07, MEPS 9901-19-06	C.3.5.5.2.A, C.3.5.8.B, C.3.5.8.C.2, C.3.5.9.A, C.3.5.9.C, C.3.5.10.2.D, C.3.5.11.A,
	Note 1: An "x" in the "No" column indicates IPLAT requires that the violation be fixed before final approval. A "w" in the "Yes" column means IPLAT is waiving the requirement.	Note 2: A bold question mark (?) in the either the "Yes" or "No" column means IPLAT requires an answer before final approval can be issued. A non-bolded question mark (?) in the "Yes" column means that MEPS should follow up on this, but no response to IPLAT is necessary.
		General comments: IPLAT will need to see the listed drawing notes (usually with a parts list and find numbers) for each of the drawings before the final evaluation. Lack of these notes significantly handicaps IPLAT's ability to review all aspects of labeling. Color and font size must be called out on the drawings. Also, PCM labels and data capture kit labels need to be approved by IPLAT. We only saw the h/w in person and in digital images. We'll need to see engineering drawings. As a last resort, IPLAT can perform the final approval based on digital images of actual flight hardware.

Acceptance Yes	No	N/A	Section#	SSP 57000 Appendix C Instruction Description[1 2]	Comments/Recommendations
		x	C.3.1	Ground Assembly And Handling. Product marking in accordance w/Mil-Std-130, sec 4, except parag 4.1.C.	Although not applicable to this evaluation, ensure labels for ground assembly and handling do not interfere with flight crew interface labeling.
			C.3.2	Function Considerations	
	x		C.3.2.A	Contains info required by user for purpose, function, and/or functional result of use of equipment.	1. R1 does not indicate the function of the dial. There should be a functional label such as REOSTAT. 2. Remove rounded arrow above H/V POWER switch. The arrow implies that the switch rotates rather than moves up and down. The arrow points to the LED but is unnecessary since the switch guard forms a group for the LED, H/V POWER, and switch designators. 3. The yellow/black striped Fire hole sticker placed over the non-functional fire hole could cause confusion for the crew. Crew would want to know why it is there and there is no explanation on it. It is recommended that the decal covering the non-functional hole should be changed to a solid color matching the background of the MEPS unit. 4. Video tape labels do not seem sufficient to explain the direction for insertion because the crew could be on either side while inserting the tape. Possibly include alignment marks on the equipment and the tape. 5. The arrows decal on the External Experiment Run Cards (based on in-person/digital image viewing, not drawings) could be confusing because arrows by themselves don't indicate orientation. Should add the word UP at the top to know which direction the arrows are supposed to point during card insertion. 7. Need to add PROCESS CONTROL CHAMBER underneath the payload name label on the chamber door. 8. The PCMs should include "PCM" on them, especially if that's how they are referred to in procedures. Then don't forget to add to your OpNom list.

*IPLAT = ISS Payload Label Approval Team

Figure D-8a. Example of ISS MEPS Payload Label Violations from IPLAT: GO/NO-GO Wording on Control Panel*

Feb 04 02 06:02p ita 6103638569 p.5

Figure 9

SSP 52000-PVP-ERP, Issue A
3/22/00

VERIFICATION REQUIREMENT DEFINITION SHEET

Verification Number	Requirement Title	Verification Method
HF-ER-014	Color	I
		Hazard Report Number

Human Factors Verification Requirement:

Payloads shall select interior colors in accordance with the requirements of SSP 52000-IDD-ERP, Table 12-I. (12.5.1)

Description of Verification Method:

An inspection/evaluation of the as-built hardware (PD equipment item/decal/placard/label) shall be performed to verify that colors are per SSP 52000-IDD-ERP, Table 12-I.

Required Verification Data:	*Data Submittal Dates:*
Certificate of Compliance (COC) with the requirement.	L-6 mo

Description of Reverification Requirements:

No reverification required.

Required Reverification Data:	*Data Submittal Dates:*
None Required.	N/A

Applicable Documents and Notes:

FED-STD-595
SSP 52000-IDD-ERP: par 12.5.1

Note: Delivery date assumes 30 days prior to turnover to KSC, and PD hardware must be turned over to KSC at L-5 months.

A-197

Figure D-9. ISS Color Requirement (1 of 2)

Figure 9, continued

12.4.6.2 Self-Supporting Covers

All access covers that are not completely removable shall be self-supporting in the open position.

12.5 IDENTIFICATION LABELING

EXPRESS Rack payloads, loose equipment, stowage trays, consumables, ORUs, crew accessible connectors and cables, switches, indicators, and controls shall be labeled. Labels are markings of any form (including Inventory Management System (IMS) bar codes) such as decals and placards, which can be adhered, "silk screened," engraved, or otherwise applied directly onto the hardware. Appendix E provides instructions for label and decal design and approval.

12.5.1 Color

Payloads shall select colors in accordance with the requirements of Table 12-I.

TABLE 12-I EXPRESS RACK PAYLOAD COLOR REQUIREMENTS

HARDWARE DESCRIPTION	COLOR	FINISH	SPECIFICATION NUMBER PER FED-STD-595B
Rack Front Aisle Extensions	Off-White	Semigloss	27722
Port, Starboard, Ceiling, or Floor Rack Faceplates	Off-White	Semigloss	27722
Port, Starboard, Ceiling, or Floor Rack Utility Panel Closeouts	Off-White	Semigloss	27722
Deck Rack Faceplates	Off-White	Semigloss	27722
Stowage Trays	Off-White	Semigloss	27722
Stowage Tray Handle Straps (any location)	Blue Material	Semigloss	25102 or equivalent
Equipment Panel Text Characters	Black	Lusterless	37038

12.5.2 Fluid Connector Pressure/Flow Indicators

All non-brazed or non-welded gas and liquid lines that will be opened/disconnected on orbit shall be provided with a positive indication of the presence of gas pressure/fluid flow to verify that the line is passive before opening/disconnecting connectors (visual indicator, etc.). Any liquid or gas lines equipped with QDs which are designed to be operated under pressure shall not be required to be fitted with pressure/flow indicators.

Figure D-9. ISS Color Requirement (2 of 2)

Feb 04 02 06:03p ita 6103638569 p.9

Figure 10

SSP 52000-PVP-ERP, Issue A
3/22/00

VERIFICATION REQUIREMENT DEFINITION SHEET

Verification Number	Requirement Title	Verification Method
HF-ER-020	Toggle Switches	I
		Hazard Report Number

Human Factors Verification Requirement:

Dimensions for a standard toggle switch shall conform to Figure 12-13 of SSP 52000-IDD-ERP, "Toggle Switches." (12.6.4)

Description of Verification Method:

An inspection/evaluation of the as-built hardware (toggle switches) shall be performed to verify that it meets the dimensions of Figure 12-13 of SSP 52000-IDD-ERP.

Required Verification Data:	*Data Submittal Dates:*
Certificate of Compliance (COC) with the requirement.	L-6 mo

Description of Reverification Requirements:

1. Same as "Verification Requirement" above.
2. Payloads remaining on-orbit past the original period of certification of the safety features or inhibits must perform a re-verification of the activities as identified in the "Description of the Verification Method" identified above.

This is the reverification requirement for safety features as per NSTS 18798B, MA2-98-135. It covers not only items that are limited operating life items (i.e., batteries, seals, etc.) but also items such as micro-switches, PRVs, etc., that perform the safety control function for a payload hazard.

Required Reverification Data:	*Data Submittal Dates:*
Same as "Required Verification Data" identified above.	L-6 mo

Applicable Documents and Notes:

SSP 52000-IDD-ERP: par 12.6.4

Note: Delivery date assumes 30 days prior to turnover to KSC, and PD hardware must be turned over to KSC at L-5 months.

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Figure D-10. Toggle Switch Requirement (1 of 3)

Figure 10, continued

B. Intermediate-Torque Valves - Valves requiring between 10 and 20 in-lb (1 and 2 N-m) for operation are classified as "intermediate torque" valves and shall be provided with a "central pivot" type handle, 2.25 in (5.5 cm) or greater in diameter, or a "lever end pivot-type" handle, 3 in (7.5 cm) or greater in length.

C. High-Torque Valves - Valves requiring 20 in-lb (2 N-m) or more for operation are classified as "high-torque" valves and shall be provided "lever type" handles 3 in (7.5 cm) or greater in length.

D. Handle Dimensions - Valve handles shall adhere to the clearances and dimensions illustrated in Figures 12-11, Valve Handle-Central Pivot Type and 12-12, Valve Handle-Lever Type.

E. Rotary Valve Controls - Rotary valve controls shall open the valve with a counter-clockwise motion.

12.6.4 Toggle Switches

Dimensions for a standard toggle switch shall conform to the values presented in Figure 12-13, Toggle Switches.

12.6.5 Stowage and Equipment Drawers/Trays

A. All latches, handles, and operating mechanisms shall be designed to be latched/unlatched and opened/closed with one hand by the 95th percentile American male to the 5th percentile female.

B. The design of latches shall be such that their status (locked/unlocked) can be determined through visual inspection.

12.6.6 Audio Devices (Displays)

A. The design of audio devices (displays) and circuits shall protect against false alarms.

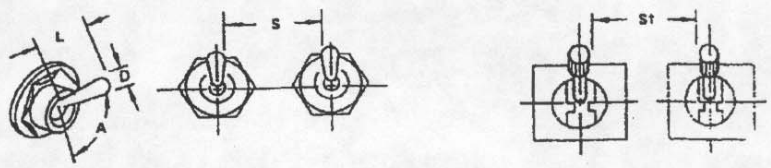
B. All audio devices (displays) shall be equipped with circuit test devices or other means of operability testing.

C. An interlocked, manual disable shall be provided if there is any failure mode which can result in a sustained activation of an audio device (display).

Figure D-10. Toggle Switch Requirement (2 of 3)

Figure 10, continued

SSP 52000-IDD-ERP, Issue B
12/13/00



	Dimensions		Resistance	
	L Arm length	D Control tip	Small switch	Large switch
Minimum	13 mm (1/2 in)	3mm (1/8 in)	2.8 N (10 oz)	2.8 N (10 oz)
Maximum	50 mm (2 in)	25 mm (1 in)	4.5 N (16 oz)	11 N (40 oz)

	Displacement between positions A	
	2 position	3 position
Minimum	30°	17°
Maximum	80°	40°
Desired		25°

	Separation S			
	Single finger operation	†	Single finger sequential operation	Simultaneous operation by different fingers
Minimum	19 mm (3/4 in)	25 mm (1 in)	13 mm (1/2 in)	16 mm (5/8 in)
Optimum	50 mm (2 in)	50 mm (2 in)	25 mm (1 in)	19 mm (3/4 in)

† Using a lever lock toggle switch

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Reference: 2, page 93

FIGURE 12-13 TOGGLE SWITCHES

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Figure D-10. Toggle Switch Requirement (3 of 3)

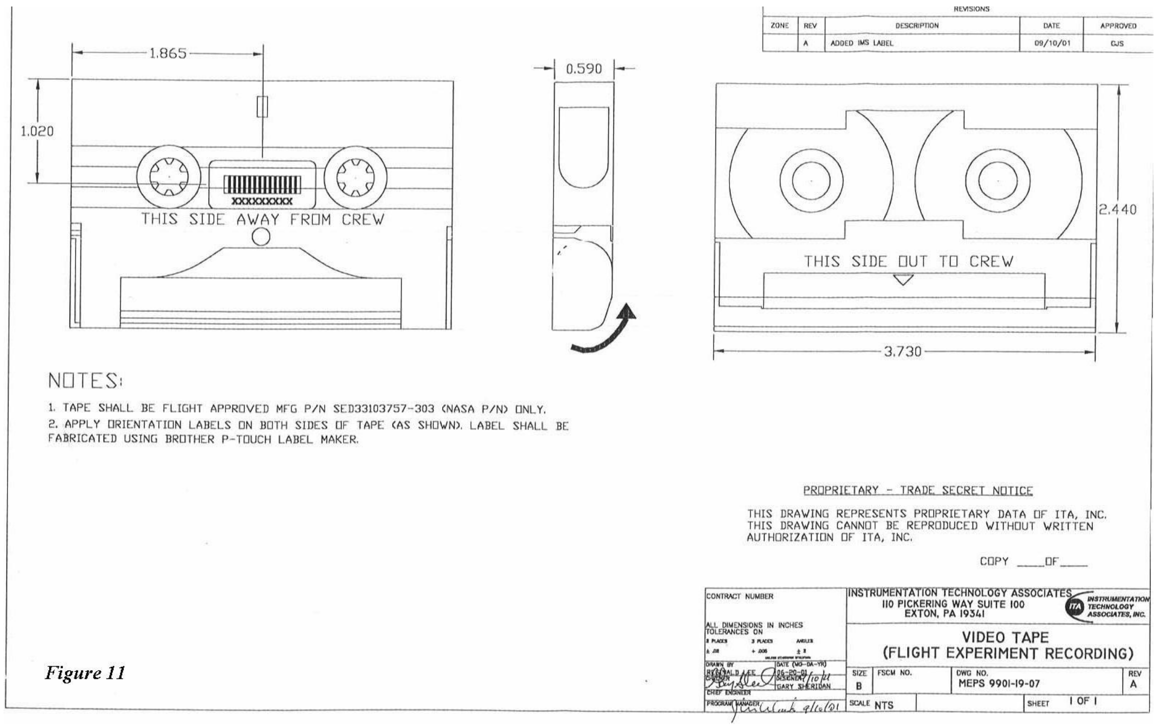

Figure D-11. Signed Off Drawing of Videotape Cassette

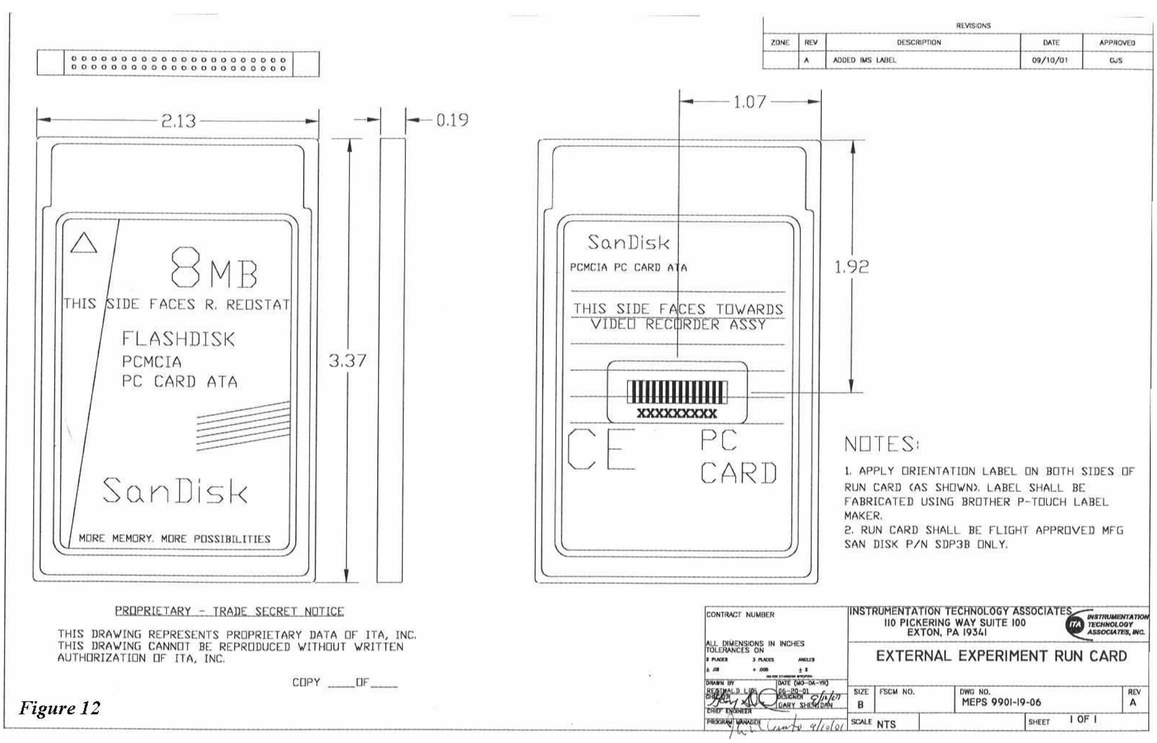

Figure D-12. Signed Off Drawing of PCMCIA Card

Appendix E
ISS Crew Time and the IMCE Report

Although the principal focus of POCASS is on ways to "save money" within Payload Operations activities, it will be a fruitless effort if there is no ability left to do meaningful research on the ISS. At the current baseline level of 20 hours/week of manned payload operations, U.S. manned science opportunities have all but disappeared. Additional threats to payload crew time include the reduced work-day hours (8 to 6 1/2), division of time between Russian, International and U.S. crew persons, and division of time among science, technology and commercial endeavors,. A focus entirely on automated telescience, controlled by ground-based PI Teams, might be all that is practical. Significant Payload Operations cost savings might be possible in this minimal scenario, although restarting manned payload activities at some future date would be very difficult and expensive, owing to loss of cadre expertise.

The recent IMCE (Young Report) holds promise of a different operations concept with substantially more crew time available. To restate several of the points in their Executive Summary (with additional explanation within the body of the Report), they "find":

- "There are opportunities to maximize research on the core station program with modest cost impact" (their stress).
- "The U.S. Core Complete configuration (three person crew) as an end-state will not achieve the unique research potential of the ISS".

And "required action":

- "Additional crew time must be allocated to support the highest priority research."

In reaching these conclusions, the Young Committee was briefed by Mr. Tommy Holloway, the NASA Director of the ISS Program. He provided several "Interim Options to Increase Crew Complement." He notes that with Soyuz missions overlapping by one month (instead of 10 to 14 days), an additional 350 hours of crew time are available for payload operations, twice per year. He also notes that if "Extended Duration Orbiter" visits are planned, docked for 16 days (instead of 7 to 9 days), an additional 500 hours for payload operations are available, twice per year, at a modest cost. If both of these independent options are combined, the available payload operations time increases from (20 hrs/week x 52) = 1040 hours to (1040 + 1700) = 2740 hours/year, a very significant increase at minimal cost.

In fact, the opportunity is substantially greater than that outlined above. Consider the following relatively minor adjustments to the Young Report recommendations.

1. NASA described a 16-day docked mission to ISS, consistent with that demonstrated on the18-day flight of STS-80 in 1996. However, STS-80 required that all Orbiter systems be fully powered for almost the full mission, depleting the stored cryogens for electricity production more rapidly than required for a docked mission at the ISS. If the Orbiter is "powered down" to a quiescent state after docking at the ISS, earlier Rockwell studies over a decade ago show power generation can be extended to 28-days or more. Mr. Arnold Aldrich, a past Space Shuttle Program Director, described this option in Space

News, April 30, 2001, pg. 14. With a docked period of approximately 28 days, manned payload operations should be extended to about 1000 hours, twice per year. Total ISS manned payload operations would now approximate 1040 (3 person crew) + 700 (Soyuz overlap) + 2,000 (EDO) = 3,740 hrs/yr.

2. Some have raised an objection to having the Orbiter Commander (CDR) return for a landing after some 30-days in space, although it has already been demonstrated as acceptable up to 18-days. It seems reasonable to work into this gradually, increasing from 20-, to 25-, to 30-days in space. Alternatively, the EDO mission can be shifted so that it immediately precedes the arrival of a new Soyuz, with slight overlap. A "fresh" U.S. CDR can be brought up in Soyuz to return the Orbiter to a landing. And finally, the Orbiter has always had a fully automatic landing capability (other than manual gear extension), although the crews have always opted for manual control in the final phase of landing.

3. Other enhancements are possible as well, including reduction of Orbiter power levels to the minimum cryo consumption rate, set by heat absorption into the cryo tanks. More expensive (and therefore deferred for now) would be modest electrical power transfer of only a few kw from ISS to Orbiter, enabling visit durations of several months.

4. Of benefit to science operations would be a concentration on infrastructure tasks during the high crew availability of the Orbiter visit as recommended in the Young Report, in return for more than 20 hours/week of payload operations during the 3-crew phases. Also, an agreement with the Russians to bring up two American and/or International crew persons on Soyuz flights, in return for two Russian crew persons on the EDO missions, would spread out the crew availability for all national interests more evenly across each increment.

5. Another benefit to crew availability would be to use a 5-month increment spacing, rather than 6-month increments as suggested in the Young report. This provides a larger fraction of the total time with larger numbers of crew, but at a corresponding increase in flight rate.

Finally turning to cost savings, as the Young Report notes, a substantial reduction of flight rate, from 6 or 7 flights/year to only 4 or 5 flights/year, is the only way to make major cost reductions. All of the above options are consistent with this, requiring only two EDO flights/year for crew exchange. Another 2 or 3 Orbiter flights may be required for Station maintenance, but the Young Report notes possible savings of as much as $669 million/year. Some of this saving should be expended for additional payload hardware and operations, again consistent with their recommendations.

Abbreviations and Acronyms

ADF	Avian Development Facility
A/G	air-to-ground
AOS	acquisition of signal
ARC	Ames Research Center
ARIS	Active Rack Isolation System
ASI	Agenzia Spaziale Italiana (Italian Space Agency)
BAA	Business Area Architecture
BANDIT	B/W integration timeliner
BNL	Brookhaven National Laboratories
BOE	basis of estimate
BPS	Bio-mass Production System
BRP	Biological Research Project
BSTC	biotechnology specimen temperature
BT	biotechnology
BTR	biotechnology research
C&DH	communications and data handling
CAM	centrifuge accommodations module
CCSDS	Consultative Committee for Space Data Standards
CD	compact disc
CEO	chief executive officer
CIR	combustion integrated rack
Code OZ	Utilization Office of the ISS Program Office
Code U	Office of Biological and Physical Research
COFR	certification of flight readiness
COR	communicator outage recorder
COTS	commercial off-the-shelf
CPO	command P/L MDM officer
CPS	Crew Planning System
CR	change request
CRV	crew rescue vehicle
CSA	Canadian Space Agency
CSC	Computer Sciences Corporation
CSOC	Consolidated Space Operations Contract
CY	calendar year
DBMS	Database Management System
DDS	Data Distribution Service
DEC	Digital Equipment Corporation
DMC	data management coordinator
DNS	domain name service
DRM	design reference mission
EDO	extended duration orbiter
EHS	Enhanced HOSC System
ERIS	EHS Remote Interface System

ESA	European Space Agency
ETOV	earth-to-orbit vehicle
EXPRESS	EXpedite the Processing of Experiments to Space Station
FB-Cell	fundamental biology-cell culture research
FC	fluids and combustion
FIR	fluid integrated rack
FTE	full-time equivalent
FTP	file transfer protocol
FY	fiscal year
GRC	Glenn Research Center
GSFC	Goddard Space Flight Center
GSP	ground support personnel
GST	ground support team
HCOR	high-rate communications outage
HOSC	Huntsville Operations Support Center
HR	human research
HRF	Human Research Facility
HRFM	high-rate frame multiplexer
HVoDS	HOSC Voice Distribution System
IBM	International Business Machines
ICE	ISS Characterization Experiment
IDRD	Integrated Data Requirements Document
IF	interface
IMCE	ISS Management and Cost Evaluation
IP	international partner
ISS	International Space Station
ISSPO	International Space Station Program Office
IT	information technology
IViDS	Internet Video Distribution System
IVoDS	Internet Voice Distribution System
JEM	Japanese Experiment Module
JOIP	Joint Operations Integration Panel
JPL	Jet Propulsion Laboratory
JSC	Johnson Space Center
KSC	Kennedy Space Center
LOE	level of effort
LSE	laboratory support equipment
LVLH	local vertical local horizontal
mb/s	megabits per second
MCC	Mission Control Center
MCOR	multipurpose communications outage recorder
MDL	middeck locker
MDM	multiplexer-demultiplexer
MIR	Russian Space Station
MOBIS	Management, Organizational, and Business Improvement Services
MOU	Memorandum of Understanding

MPV	manual procedures viewer
MS	material science
MSFC	Marshall Space Flight Center
MSG	microgravity science glovebox
NAC	NASA Advisory Council
NASA	National Aeronautics and Space Administration
NASDA	National Space Development Agency of Japan
NDE	non-real time development environment
NDL	near real time data log
NISN	NASA Integrated Services Network
NMS	Network Management System
NRT	near real time
NTP	network time protocol
OC	operations controller
OCMS	Operations Control Management System
OCR	operations change request
OMB	Office of Management and Budget
OOS	on-orbit summary
Opns	operations
OTE	operations test equipment
PAI	payload analytical integration
PARC	payload activity requirements collection
PBS	President's Budget Submission
PC	personal computer
PCB	Payload Control Board
PCC	Partner Control Centers
PCG	protein crystal growth
PD	payload developer
PDL	Payload Data Library
PDRF	payload data request form
PDRP	Payload Data Review Panel
PDRT	Payload Display Review Team
PDSS	Payload Data Services System
PHANTOM	photo & TV operations manager
PI	principal investigator
PIMS	Payload Information Management System
PIRNs	program interface revision notices
PL	payload
PLSS	Payload Support Systems
PLUM	payload utilization modeler
POC	point of contact
POCAAS	Payload Operations Concepts and Architecture Study
POD	payload operations director
PODF	payload operations data file
POH	Payload Operations Handbook
POIC	Payload Operations Integration Center

POIF	Payload Operations Integration Function
POIWG	Payload Operations Interface Working Group
PPM	payload planning manager
PPS	Payload Planning System
PPSE	P/L planning/scheduling engineer
PRO1	payload rack officer 1
PRO2	payload rack officer 2
PSE	payload systems engineer
PTC	Payload Training Complex
PUFF	The Effect of EVA and Long-Term Exposure to Microgravity on Pulmonary Function
RFP	Request for Proposal
ROSE	request-oriented scheduling engine
RPI	remote principal investigator
RPOs	Research Program Offices
RPWG	Research Planning Working Group
RSA	Russian Space Agency
RT	real time
SAMS	Space Acceleration Measurement System
SAT	science, aeronautics, and technology
SFOC	Space Flight Operations Contract
SGI	Silicon Graphics Incorporated
SLOC	source lines of code
SMAC	system monitor & control
SOC	shuttle operations coordinator
SOMO	Space Operations Management Office
SOW	scope of work
SPD	Space Product Development
SSCC	Space Station Control Center
SSP	Space Shuttle Program
SSTF	Space Station Training Facility
STP	short term plan
STS	Space Transportation System
SW	software
TBE	Teledyne Brown Engineering
TCO	timeline change officer
TCP/IP	transfer control protocol/interface protocol
TDRSS	Tracking and Data Relay Satellite System
TDS	Time Distribution System
TMM	timeline maintenance manager
TSC	Telescience Support Center
	Training Support Contract
UMS	Utilization Mission Support
UPN	universal project number
USOC	United States Operations Center
VBSP	video baseband signal processor

WAN	wide area network
WISARD	weekly data systems/resources
WORF	Window Observational Research Facility
WSC	White Sands Center
XPOP	X-axis perpendicular to orbit plane
ZCG-FU	Zeolite Crystal Growth